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VALIDATION OF A STATISTICAL MATCHING PROCEDURE USED TO CREATE UNITED STATES MARINE CORPS ANTHROPOMETRIC DATABASES

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Anthropometric databases containing extensive body size and shape information are critical for the proper design and sizing of military clothing, equipment and workstations. The last anthropometric survey of United States Marine Corps males was conducted in 1966. No anthropometric data has been collected on Marine Corps females. To update the anthropometric database, the USMC requested that the U.S. Army Natick Research, Development and Engineering Center conduct a validation study to determine if statistical matching could be used to create accurate male and female USMC anthropometric databases using data collected during the 1988 Anthropometric Survey of U.S. Army Personnel (ANSUR). Anthropometric data were collected from a randomly selected sample of male and female USMC personnel. Twelve anthropometric dimensions chosen to describe all major segments of the body were measured on a valid sample of 470 females and 493 male Marines. These data were compared to matched databases derived from ANSUR using several different matching procedures, including truncation based on height for weight standards, demographic (race/age) matching, and demographic plus weight and/or height matching.

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Table of Contents

List of Tables

List of Tables (Cont.)

Preface and Acknowledgements

VALIDATION OF A STATISTICAL MATCHING PROCEDURE USED TO CREATE UNITED STATES MARINE CORPS ANTHROPOMETRIC DATABASES

Introduction

Anthropometric databases containing extensive body size and shape information are critical for the proper design and sizing of clothing, protective equipment and workstations used by military populations. These databases must be assessed periodically and updated to ensure that they accurately describe the populations they purport to represent. The most recent anthropometric survey of the United States Marine Corps (USMC) male population was conducted in 1966, and no anthropometric data have been collected on female Marines[1].

To update the anthropometric database, the USMC requested that the US Army Natick Research, Development and Engineering Center conduct a validation study to determine if statistical matching could be used to create accurate male and female USMC anthropometric databases using data collected during the 1988 Anthropometric Survey of US Army Personnel (ANSUR). Earlier research has shown that statistical matching can be used to successfully create databases that anthropometrically represent the US Army Pilot population[2]. In addition, when USMC and US Army anthropometric data from the 1966 survey were compared, the two populations exhibited very similar anthropometric distributions in both body size and shape[1].

To validate the matching procedure used to create the USMC databases, anthropometric data were collected from a randomly selected sample of male and female USMC personnel. A total of 12 anthropometric dimensions, carefully chosen to accurately describe all major segments of the body, were measured on a valid sample of 470 female and 493 male marines during the summer of 1994. These subjects were measured at Camp Pendleton and Camp LeJeune.

A discussion of sample acquisition begins on page 1. Observer error rates are presented on page 9. The validation of the matching procedure for males begins on page 12 and is followed by the female validation on page 18. Appendix A contains a sample Resampling Stats program, and the appendices B and C present summary statistics for the measured male and female USMC samples and the matched databases that were tested. Appendix D explains the derivation of the formula used to determrmine a valid sample size.

Sample Acquisition

During the summer of 1994, 12 anthropometric dimensions were collected on a total of 495 male and 486 female marines. Among the males, one subject was eliminated from the analysis because a recent accident resulted in severe weight gain and fluid retention. One of the Hispanic males in the oldest age category was also removed from the analysis because he was the shortest measured subject (Stature = 1532 mm) and was unduly influential due to his demographic profile. Thus, a total of 493 valid male subjects were measured and retained for use in the validation study.

Among the female sample, one of the subjects was not actually measured, 4 women were 8 weeks or less postnatal and lactating, 1 was separating from the USMC because she was very heavy, and 1 did not meet the minimum waiverable height requirements and was substantially shorter than the next shortest subject. Hairstyles interfered with Stature and Sitting Height measurements for 9 of the female subjects, requiring that the anthropometer blade be inserted initially at an angle to take these measurements. Since this may have had an unknown effect on these measurements, and Stature was used as one of the matching criteria, these subjects were also excluded from the analysis, reducing the valid sample to 470.

1. Minimum Sample Required

The minimum number of subjects needed to provide accurate parametric estimates of both the mean and the tails (i.e., 5th and 95th percentile values) was calculated separately for males and females using the following equation (see Appendix D):

$$n = [(1.96 \ast SD)^2 \ast (1 + 0.5 \ast k^2)] / C^2$$

where:
        n = number of subjects
        SD = standard deviation
        k = Z-score corresponding to the desired accommodation rate
        C = precision

The standard deviation and precision values were set using the ANSUR data. Precision was set at 1.5% of the mean for soft tissue measurements (e.g., Chest Circumference) and 1.0% of the mean for bony measurements (e.g., Stature)[3]. As presented in Table 1, the measurement requiring the largest minimum sample size was Weight. However, budgetary constraints would not allow for such a large number of subjects to be measured, so the minimum sample size for Waist Circumference (Omphalion) was used for the sampling strategy. The chosen sample size ensured that accurate parametric estimates of Weight could be

2

made for the USMC mean and for the 33rd and 67th percentiles of the population [Male n = [(1.96*11.1)^2 * (1 + 0.5*0.44^2)] / 1.18^2 = 375; Female n = [(1.96*8.35)^2 * (1 + 0.5*0.44^2)] / 0.93^2 = 340].

Table 1. Computed Minimum Sample Size Requirements for Accurate Parametric Estimates							
	Males				Females		
	Mean	Precision	Standard Deviation	Minimum N	Mean	Precision	Standard Deviation	Minimum N
Stature	175.58	1.76	6.68	131	162.94	1.63	6.36	138
Weight	**78.49**	**1.18**	**11.1**	**803**	**62.01**	**0.93**	**8.35**	**728**
Waist Ht	105.88	1.06	5.09	209	98.21	0.98	4.88	223
Sleeve	60.15	0.60	3.07	235	54.72	0.55	3.02	275
Chest C	99.14	1.49	6.9	195	90.71	1.36	6.35	197
Waist C	**86.24**	**1.29**	**8.64**	**403**	**79.19**	**1.19**	**8.27**	**438**
Butt C	98.37	1.48	6.22	161	96.69	1.45	6.02	156
Foot B	10.06	0.10	0.53	251	8.97	0.09	0.49	270
Foot L	26.97	0.27	1.31	213	24.44	0.24	1.22	225
Sitt Ht	91.39	0.91	3.56	137	85.2	0.85	3.49	152
Head C	56.77	0.57	1.54	66	54.62	0.55	1.46	64
MenSell	12.19	0.12	0.65	257	11.35	0.11	0.6	253

The minimum number of males and females to be measured was multiplied by the proportion of USMC personnel in each of the age/race sampling cells to determine the minimum number of Marines that must be measured in each demographic cell. The male and female demographic distributions of the USMC population, presented in Tables 2 and 3, were used to calculate the sampling goals (see Tables 4 and 5 for the minimum cell requirements). To ensure that these goals were met, each cell was over-sampled by 20% during the rostering process to compensate for any attrition.

Table 2. USMC Male Demographic Distribution DMDC Data December 1993

	White	Black	Hispanic	As/Pa Is	Am Ind	Mixed/O	Total
≤ 20	32487	5322	4069	641	381	568	43468
	19.22%	3.15%	2.41%	0.38%	0.22%	0.34%	25.72%
21-24	41839	8075	5092	920	520	592	57038
	24.75%	4.78%	3.01%	0.54%	0.31%	0.35%	33.75%
25-30	22503	6323	2228	509	256	314	32133
	13.31%	3.74%	1.32%	0.30%	0.15%	0.19%	19.01%
≥ 31	125775	7334	2256	547	182	261	36355
	15.25%	4.34%	1.33%	0.32%	0.11%	0.15%	21.51%
Total	122604	27054	13645	2617	1339	1735	168994
	72.55%	16.01%	8.07%	1.55%	0.79%	1.03%	100.00%

Table 3. USMC Female Demographic Distribution DMDC Data December 1993

	White	Black	Hispanic	As/Pa Is	Am Ind	Mixed/O	Total
≤ 20	1192	354	202	35	40	35	1858
	15.69%	4.66%	2.66%	0.46%	0.53%	0.46%	24.45%
21-24	1455	604	249	49	55	40	2452
	19.15%	7.95%	3.28%	0.64%	0.72%	0.53%	32.27%
25-30	966	516	119	28	23	29	1681
	12.71%	6.79%	1.56%	0.37%	0.30%	0.38%	22.12%
≥ 31	977	484	113	11	10	13	1608
	12.86%	6.37%	1.49%	0.14%	0.13%	0.17%	21.16%
Total	4590	1958	683	123	128	117	7599
	60.40%	25.77%	8.99%	1.62%	1.68%	1.54%	100.00%

2. Sample Size Acquired

As shown in Tables 4 and 5, the minimum sampling goals were met for most of the demographic cells. Among the males, the minimum sampling goals were not met for three cells. The goals were not met by only a single subject for the White 25-30 year olds and the Asian/Pacific Islander over 31 age group, while that of the White 21-24 year old cell was not met by 5 subjects. Although

this figure does represent 5% of this age/race cell, it should also be noted that this is the most populous demographic group in the USMC population and that a large number of subjects were successfully measured.

Table 4. Demographic Distribution of Valid Male Sample and Minimum Sampling Requirements

	White		Black		Hispanic		Asian/Pa Islander		American Indian		Mixed/ Other		Total	
	Valid	Min	Valid	Min	Valid	Min	Valid	Min	Valid	Min	Valid	Min	Valid	Min
≤ 20	113	77	23	13	15	10	2	2	1	1	12	1	166	104
21-24	*95*	*100*	22	19	18	12	2	2	2	1	5	1	144	136
25-30	*53*	*54*	21	15	5	5	1	1	1	1	6	1	87	77
≥ 31	65	61	21	17	5	5	*1*	*2*	1	0	3	1	96	86
Total	326	292	87	64	43	32	6	7	5	3	27	4	493	403

*Cells in bold italics indicate shortfalls

For the female sample, the minimum measuring goals were not met for a total of 6 age/race cells. The White 21-24, 25-30, ≥ 31 and cells are under-represented by 4, 5 and 2 respectively (see Table 5). The minimum goals for the remaining cells (Black 25-30, Hispanic 21-24, Asian/Pacific Islander 25-30) were not met by 2 subjects.

Table 5. Demographic Distribution of Valid Female Sample and Minimum Sampling Requirements

	White		Black		Hispanic		Asian/Pa Islander		American Indian		Mixed/ Other		Total	
	Valid	Min	Valid	Min	Valid	Min	Valid	Min	Valid	Min	Valid	Min	Valid	Min
≤ 20	74	69	23	20	20	12	0	2	5	2	11	2	133	107
21-24	*78*	*84*	35	35	*12*	*14*	4	3	4	3	9	2	142	141
25-30	*49*	*56*	*28*	*30*	11	7	*0*	*2*	2	1	7	2	97	98
≥ 31	*54*	*56*	31	28	10	7	1	0	0	0	2	1	98	92
Total	255	265	117	113	53	40	5	7	11	6	29	7	470	438

*Cells in bold italics indicate shortfalls

Given the number of male subjects successfully measured in each of the cells, the exact confidence level associated with the 33.3% and the 66.6% parametric estimates for Weight in the male sample is 94.64%, very close to 95%. For the female sample, estimates of the 33.3% and the 66.6% percentiles can be estimated with 95% confidence. Thus, the estimates for the most variable anthropometric distribution, Weight, can still be made with confidence levels either at, or very close to, 95% and so the shortfall in measuring goals should not impact the validation.

For most of the cells, the difference between the number of subjects actually measured and the minimum number required tended to be between 5% and 10%. It may be that an attrition rate of 25%, rather than 20%, should be expected when rostering subjects in advance to prevent shortfalls. The problem of subject accession rates was greater among the females than the males and was probably effected by female Marines who were either pregnant or on maternity leave at the time of the survey. Such problems could be minimized during the rostering process by requesting that each participating base exclude individuals from rosters who are known to be pregnant or have just returned from maternity leave.

3. Age/Race Distribution of Valid Sample and Current USMC

The most current age/race distribution of the USMC population at the time the validation study began is presented in Tables 6 and 7. Tables 8 and 9 present the number of valid measured USMC subjects that need to be selected in each age/race cell to match the observed USMC demographic distributions. Because the total number of subjects in each data set is already small, it would not be advisable to randomly delete a total of 128 male subjects and 135 female subjects. To retain all of the valid measured subjects (Tables 10 and 11), and to have a demographically representative database, the valid male and female data were weighted using the weighting factors presented in Tables 12 and 13 . The weights were simply calculated using division. For example, a total of 113 White males were measured in the $\leq$ 20 age category (see Table 10). As shown in Table 8, only 70 subjects should occupy this cell based on the current USMC male demographic data. By dividing 70 by 113, the weighting factor of .6195 is calculated (see Table 12). Thus, each of the 113 subjects in this age/race group will be given a weight of only .6195, instead of a full weight of 1. With the weighting factor, all 113 subjects are used, but they only have the impact of 70 subjects (i.e., 113 x .6195 = 70). The appropriate weighting factors were applied to both the male and the female data sets for use throughout the analysis.

Table 6. USMC Male Demographic Distribution February 1995

	White	Black	Hispanic	Asian/Pa Islander	American Indian	Mixed/ Other	Total
≤ 20	31821	5178	4502	693	392	507	43093
	19.16%	3.12%	2.71%	0.42%	0.24%	0.31%	25.95%
21-24	41689	7667	5626	994	481	656	57113
	25.10%	4.61%	3.39%	0.60%	0.29%	0.39%	34.39%
25-30	21078	5602	2270	546	233	299	30028
	12.69%	3.37%	1.37%	0.33%	0.14%	0.18%	18.08%
≥ 31	25168	7384	2300	528	201	275	35856
	15.15%	4.44%	1.38%	0.32%	0.12%	0.17%	21.59%
Total	119756	25831	14698	2761	1307	1737	166090
	72.10%	15.55%	8.85%	1.66%	0.79%	1.04%	100.00%

Table 7. USMC Female Demographic Distribution February 1995

	White	Black	Hispanic	Asian/Pa Islander	American Indian	Mixed/ Other	Total
≤ 20	1322	385	271	50	40	26	2094
	17.05%	4.96%	3.50%	0.64%	0.52%	0.34%	27.01%
21-24	1456	551	269	50	46	42	2414
	18.78%	7.11%	3.47%	0.64%	0.59%	0.54%	31.14%
25-30	882	476	134	32	21	36	1581
	11.38%	6.14%	1.73%	0.41%	0.27%	0.46%	20.39%
≥ 31	987	510	125	13	12	17	1664
	12.73%	6.58%	1.61%	0.17%	0.15%	0.22%	21.46%
Total	4647	1922	799	145	119	121	7753
	59.94%	24.79%	10.31%	1.87%	1.53%	1.56%	100.00%

Table 8. February 1995 Demographically Representative Distribution of Valid Measured USMC Males

	White	Black	Hispanic	Asian/Pa Islander	American Indian	Mixed/ Other	Total
≤ 20	70	11	10	2	1	1	95
	19.18%	3.00%	2.70%	0.60%	0.30%	0.30%	26.13%
21-24	92	17	12	2	1	1	125
	25.20%	4.50%	3.30%	0.60%	0.30%	0.30%	34.23%
25-30	46	12	5	1	1	1	66
	12.60%	3.30%	1.50%	0.30%	0.30%	0.30%	18.32%
≥ 31	55	16	5	1	1	1	79
	15.07%	2.10%	0.60%	0.00%	0.00%	0.00%	10.81%
Total	263	56	32	6	4	4	365
	72.05%	15.32%	8.71%	1.80%	0.90%	0.90%	100.00%

Table 9. February 1995 Demographically Representative Distribution of Valid Measured USMC Females

	White	Black	Hispanic	Asian/Pa Islander	American Indian	Mixed/ Other	Total
≤ 20	59	17	12	0	2	1	91
	17.15%	4.94%	3.49%	0.00%	0.58%	0.29%	26.45%
21-24	65	25	12	3	2	2	109
	18.90%	7.27%	3.49%	0.87%	0.58%	0.58%	31.69%
25-30	39	21	6	0	1	2	69
	11.34%	6.10%	1.74%	0.00%	0.29%	0.58%	20.06%
≥ 31	44	23	6	1	0	1	75
	12.79%	6.69%	1.74%	0.29%	0.00%	0.29%	21.80%
Total	207	86	36	4	5	6	344
	60.17%	25.00%	10.46%	1.16%	1.45%	1.74%	100.00%

Table 10. Valid Measured USMC Male Demographic Distribution

	White	Black	Hispanic	Asian/Pa Islander	American Indian	Mixed/ Other	Total
≤ 20	113	23	15	2	1	12	166
21-24	95	22	18	2	2	5	144
25-30	53	21	5	1	1	6	87
≥ 31	65	21	5	1	1	3	96
Total	326	87	43	6	5	26	493

Table 11. Valid Measured USMC Female Demographic Distribution

	White	Black	Hispanic	Asian/Pa Islander	American Indian	Mixed/ Other	Total
≤ 20	74	23	20	0	5	11	133
21-24	78	35	12	4	4	9	142
25-30	49	28	11	0	2	7	97
≥ 31	54	31	10	1	0	2	98
Total	255	117	53	5	11	29	470

Table 12.	Weighting Factors for Valid Measured USMC Males to Match February 1995 USMC Demographic Distribution					
	White	Black	Hispanic	Asian/Pa Islander	American Indian	Mixed/ Other
≤ 20	0.6195	0.4783	0.6667	1.0000	1.0000	0.0833
21-24	0.9684	0.7727	0.6667	1.0000	0.5000	0.2000
25-30	0.8679	0.5714	1.0000	1.0000	1.0000	0.1667
≥ 31	0.8462	0.7619	1.0000	1.0000	1.0000	0.3333

Table 13.	Weighting Factors for Valid Measured USMC Females to Match February 1995 USMC Demographic Distribution					
	White	Black	Hispanic	Asian/Pa Islander	American Indian	Mixed/ Other
≤ 20	0.7973	0.7391	0.6000	0.0000	0.4000	0.0909
21-24	0.8333	0.7143	1.0000	0.7500	0.5000	0.2222
25-30	0.7959	0.7500	0.5454	0.0000	0.5000	0.2857
≥ 31	0.8148	0.7419	0.6000	1.0000	0.0000	0.5000

Interobserver Error

A total of 13 female and 20 male subjects were measured twice, once by each member of the measuring team. The collected data served two purposes: 1) as a daily check to ensure that measurers did not exceed the allowable errors established for each dimension; and 2) to collect interobserver error data.

When the values of measurements taken by Measurer 2 (M2) were subtracted from those taken by Measurer 1 (M1), the number of positive and negative values for several dimensions suggested that directionality (i.e., the proportion of positive and negative values not being equal) may be present. To determine if directionality was present, a bootstrapping program was written in Resampling Stats to test the null hypothesis that, on average, for 50% of the test-retest data M1 measured larger than M2 (M1>M2), and for the other 50% of the data, M1 measured smaller than M2 (M1<M2). Because the proportion of ties that would be expected for any particular dimension cannot be determined independently of the test-retest data, ties were not included in the analysis (see Appendix A for a sample program).

Among the females, the null hypothesis was rejected for three dimensions (Chest Circumference [M1>M2], Buttock Circumference [M1<M2], and Head Circumference [M1<M2]), and among the males, only one dimension (Foot Breadth [M1>M2]) exhibited directionality (see Table 14). The presence of directionality does *not* indicate that the magnitude of the difference between the measurers is large or that the quality of measuring was poor. Directionality does suggest that the distribution of the interobserver error data does not center around 0 and is not normally distributed.

In addition to directionality being present, the number of subjects measured twice is relatively small (n=13 for females and n=20 for males). Furthermore, Table 15 shows that many of the interobserver error distributions are skewed and kurtotic. The combination of these factors results in a dubious parametric estimate using the mean value, and indicates that median values should be used. Therefore, the absolute median value of the test-retest data was chosen as an indicator of interobserver error for the USMC data set, rather than the mean absolute difference (MAD). The USMC study and ANSUR interobserver errors are presented in Table 16.

Table 14. Directionality Between Measurers by Sex of Subjects					
Dimension	**M1>M2**	**M1<M2**	**M1=M2**	**N**	***p***
Females					
Stature	6	6	1	13	.61
Waist Height	4	9	0	13	.13
Sleeve	4	7	2	13	.27
Chest Circ	10	2	1	13	**.02**
Waist Circ	8	4	1	13	.19
Buttock Circ	2	9	2	13	**.01**
Foot Breadth	6	5	2	13	.50
Foot Length	5	3	5	13	.36
Sitting Height	4	7	2	13	.27
Head Circ	1	12	0	13	**.00**
Menton-Sellion	4	8	1	13	.19
Males					
Stature	8	8	4	20	.60
Waist Height	7	13	0	20	.14
Sleeve	9	10	1	20	.51
Chest Circ	7	11	2	20	.25
Waist Circ	12	7	1	20	.19
Buttock Circ	12	8	0	20	.24
Foot Breadth	12	4	4	20	**.04**
Foot Length	7	7	6	20	.60
Sitting Height	11	6	3	20	.16
Head Circ	8	11	1	20	.33
Menton-Sellion	10	5	5	20	.14

Dimension	Skewness	Kurtosis	MAD	|Median|
Table 15. Skewness, Kurtosis, Mean Absolute Difference, and Absolute Median of Interobserver Error Data by Sex				
Females				
Weight	0.45	2.31	0.7	1.0
Stature	-0.75	2.39	2.6	2.0
Waist Height	0.38	1.86	2.7	3.0
Sleeve	-1.33	4.11	2.6	2.0
Chest Circ	1.06	4.15	7.6	6.0
Waist Circ	0.30	4.10	10.6	5.0
Buttock Circ	1.97	6.93	3.5	2.0
Foot Breadth	0.20	2.42	1.5	1.0
Foot Length	0.55	2.80	1.2	1.0
Sitting Height	-1.11	3.76	2.8	2.0
Head Circ	-1.58	4.71	5.2	3.0
Menton-Sellion	1.47	4.78	2.5	2.0
Males				
Weight	1.91	6.52	1.8	1.0
Stature	0.56	3.26	2.3	2.0
Waist Height	0.19	2.04	3.6	3.5
Sleeve	0.96	4.08	4.4	2.5
Chest Circ	1.05	3.52	11.3	7.0
Waist Circ	-0.03	2.01	5.2	6.0
Buttock Circ	-0.81	3.40	6.4	5.0
Foot Breadth	0.14	3.06	1.2	1.0
Foot Length	-0.27	2.43	1.0	1.0
Sitting Height	-0.21	2.22	3.7	3.5
Head Circ	0.38	2.24	2.6	2.5
Menton-Sellion	-0.92	4.42	1.4	1.0

Table 16. Interobserver Error Values for USMC and ANSUR

	Male			Female		
	USMC	ANSUR	Combined	USMC	ANSUR	Combined
Weight	1.00	1.20	2.20	1.00	0.80	1.80
Stature	2.00	2.94	4.94	2.00	2.72	4.72
Waist Ht	3.50	2.74	6.24	3.00	2.98	5.98
Sleeve	2.50	3.91	6.41	2.00	2.91	4.91
Chest C	7.00	6.88	13.88	6.00	6.22	12.22
Waist C	6.00	4.33	10.33	5.00	6.34	11.34
Buttock C	5.00	4.37	9.37	2.00	4.15	6.15
Foot Br	1.00	0.60	1.60	1.00	0.56	1.56
Foot L	1.00	0.53	1.53	1.00	0.47	1.47
Sitt Ht	3.50	3.14	6.64	2.00	2.77	4.77
Head Circ	2.50	0.82	3.32	3.00	1.19	4.19
MenSell	1.00	1.01	2.01	2.00	1.05	3.05

USMC Male Matched Database Validation

1. Truncation Using USMC Weight for Height Standards

Table 17 presents the Weight for Height retention standards for USMC males[4]. When the male validation sample was compared to these standards, it was found that the measured Marines met all of the standards for Height and minimum Weight for Height. However, 123 (24.8%) of the measured subjects exceed the maximum Weight for Height standards. Thus, only the Height and minimum Weight requirements were used to truncate the ANSUR male database prior to matching. After truncation, a total of 5103 subjects were still available for matching.

Table 17. Height and Weight Retention Standards for Male USMC Personnel (MCO P6100.3H)		
	Male Weight Standards	
Height (in)	**Minimum Weight (lb)**	**Maximum Weight (lb)**
60*	100	160**
61	102	160
62	103	160
63	104	160
64	105	160
65	106	165
66	107	170
67	111	175
68	115	181
69	119	186
70	123	192
71	127	197
72	131	203
73	135	209
74	139	214
75	143	219
76	147	225
77	151	230
78	153	235

*Measurements of 0.5 inches or more are rounded up to the next higher inch and measurements of less than 0.5 inches are rounded down. Each height category is actually a range, so 68 inches is the range 67.5 to 68.5 inches.

**For male standards, 64 inches is the shortest height with a maximum allowable weight standard. This standard was also applied to the shorter height categories.

2. Demographic Only (Race/Age) Matching

The demographic distribution of the truncated ANSUR male database is presented in Table 18. The weighting factors in Table 19 were used to weight the entire truncated database to produce the same demographic distribution of both the weighted male USMC validation sample and the February 1995 USMC male population. The weights were calculated by dividing the number of desired subjects in each age/race cell (Table 8) by the number of available ANSUR subjects (Table 18). As shown in Table 20, the male Marines have significantly larger Chest Circumferences and taller Sitting Heights on average when compared to the Race/Age matched database. The summary statistics in Appendix B also show that the USMC male distribution for Stature tends to be slightly taller and the distribution for Weight is heavier by approximately 5 pounds throughout the percentiles. Because this matching procedure failed to control predominately Weight and Chest Circumference, a second matching procedure was tested in which Race, Age, and Weight were controlled simultaneously.

Table 18. Demographic Distribution of Truncated ANSUR Male Database						
	White	Black	Hispanic	Asian/Pa Islander	American Indian	Mixed/ Other
≤ 20	404	365	205	49	22	117
21-24	411	363	279	92	34	163
25-30	402	362	281	120	19	96
≥ 31	404	360	282	177	9	87

Table 19. Demographic Only Match Weighting Factors for Truncated ANSUR Males						
	White	Black	Hispanic	Asian/Pa Islander	American Indian	Mixed/ Other
≤ 20	0.1733	0.0301	0.0488	0.0408	0.0454	0.0085
21-24	0.2238	0.0468	0.0430	0.0217	0.0294	0.0061
25-30	0.1144	0.0331	0.0178	0.0083	0.0526	0.0104
≥ 31	0.1361	0.0444	0.0177	0.0056	0.1111	0.0115

	USMC Male Mean	Matched Mean	F	p	t	p
Stature	1757.97	1754.66	1.02	.818	0.67	.504
Weight	790.90	778.18	1.15	.190	1.65	.100
Waist Height	1061.15	1057.09	1.02	.820	1.08	.280
Sleeve	594.98	599.35	1.01	.912	-1.95	.052
Chest Circ	1009.81	989.21	1.13	.244	3.99	.000*
Waist Circ	872.05	858.16	1.06	.601	2.24	.025
Buttock Circ	992.04	981.11	1.06	.573	2.47	.014*
Foot Breadth	100.18	100.56	1.7	.537	-0.96	.337
Foot Length	269.08	268.90	1.05	.633	0.20	.841
Sitting Height	924.64	915.71	1.12	.286	3.54	.000*
Head Circ	568.80	567.26	1.05	.640	1.38	.167
Menton-Sellion	122.09	121.72	1.09	.429	0.76	.449

Table 20. T-test Results Comparing Means of USMC Male Sample and Race/Age Match

*significantly different means at $p \leq .05$ using a Bonferroni correction for multiple comparisons

3. Race/Age/Weight Matching

The Weight distribution of the USMC male sample was divided into thirds using the 33.3% (774.929) and the 66.6% (830) values. The demographic distribution of the USMC sample was then determined for each of the Weight ranges (see Table 21). The demographic distribution of the ANSUR subjects in each of the Weight categories was also determined and is presented in Table 22. Weighting factors were calculated for each of the Race/Age/Weight cells (see Table 23). A total of 4447 subjects were included in this match.

On average and throughout the percentiles the USMC males are approximately 7 mm taller for Sitting Height compared to the match. While this difference is statistically significant, the magnitude of the difference is not large considering that the combined interobserver error rate is 6.64 mm. Furthermore, this dimension is usually used for workstation/cockpit design and the difference is not large enough to have an adverse impact when used for such a purpose. Differences between the USMC males and the matched database were negligible for the remaining 11 dimensions. Thus, this matching method was validated and when the weighting factors in Table 23 are applied to the

truncated male ANSUR database, the result is anthropometrically representative of the current male USMC population.

Table 21. USMC Male Demographically Representative Sample Divided into Three Weight Groups Using Percentiles						
	White	Black	Hispanic	Asian/Pa Islander	American Indian	Mixed/ Other	Total
Weight < 33.3% (744.929)							
≤ 20	34	3	5	0	0	0	42
21-24	33	7	6	1	1	0	48
25-30	10	3	1	0	0	1	15
≥ 31	8	5	1	0	1	0	15
Weight 33.3% to 66.6% (744.929 - 830.000)							
≤ 20	18	6	4	1	0	1	30
21-24	32	8	3	0	0	0	43
25-30	16	3	2	0	1	0	22
≥ 31	22	4	3	1	0	1	31
Weight > 66.6% (830.000)							
≤ 20	18	2	1	1	1	0	23
21-24	27	2	3	1	0	1	34
25-30	20	6	2	1	0	0	29
≥ 31	25	7	1	0	0	0	33
Total	263	56	32	6	4	4	365

	White	Black	Hispanic	Asian/Pa Islander	American Indian	Mixed/ Other	Total
Table 22. Demographic Distribution of Truncated ANSUR Males in Three Weight Groups							
Weight < 33.3% (744.929)							
≤ 20	196	201	130	30	14	71	642
21-24	159	155	142	60	15	77	608
25-30	151	119	137	65	5	44	521
≥ 31	110	88	112	100	3	30	443
Weight 33.3% to 66.6% (744.929 - 830.000)							
≤ 20	130	99	50	15	7	29	330
21-24	147	107	81	14	10	46	405
25-30	107	107	85	28	10	27	364
≥ 31	119	105	98	43	1	20	386
Weight > 66.6% (830.000)							
≤ 20	78	65	25	4	1	17	190
21-24	105	101	56	18	9	40	329
25-30	144	136	59	27	4	25	395
≥ 31	175	167	72	34	5	37	490
Total	1621	1450	1047	438	84	463	5103

19

Table 23. Race/Age/Weight Match Weighting Factors for Truncated ANSUR Males						
	White	Black	Hispanic	Asian/Pa Islander	American Indian	Mixed/ Other
Weight < 33.3% (744.929)						
≤ 20	.173469	0.014925	0.038462	0.000000	0.000000	0.000000
21-24	.207547	0.045161	0.042254	0.016667	0.066667	0.000000
25-30	.066225	0.025210	0.007299	0.000000	0.000000	0.022727
≥ 31	.072727	0.056818	0.008928	0.000000	0.333333	0.000000
Weight 33.3% to 66.6% (744.929 - 830.000)						
≤ 20	0.138462	0.060606	0.080000	0.066667	0.000000	0.034483
21-24	0.217687	0.074766	0.037037	0.000000	0.000000	0.000000
25-30	0.149533	0.028037	0.023529	0.000000	0.100000	0.000000
≥ 31	0.184874	0.038095	0.030612	0.023256	0.000000	0.050000
Weight > 66.6% (830.000)						
≤ 20	0.230769	0.030769	0.040000	0.250000	1.000000	0.000000
21-24	0.257143	0.019802	0.053571	0.055556	0.000000	0.025000
25-30	0.138889	0.044118	0.033898	0.037037	0.000000	0.000000
≥ 31	0.142857	0.041916	0.013889	0.000000	0.000000	0.000000

	USMC Male Mean	Matched Mean	F	p	t	p
Stature	1757.97	1759.03	1.00	.981	-0.22	.829
Weight	790.90	790.66	1.11	.319	0.03	.974
Waist Height	1061.15	1060.12	1.00	.967	0.30	.761
Sleeve	594.98	601.13	1.03	.785	-2.75	.006
Chest Circ	1009.81	996.19	1.15	.180	2.65	.008
Waist Circ	872.05	866.60	1.05	.615	0.88	.380
Buttock Circ	992.04	987.55	1.03	.813	0.96	.337
Foot Breadth	100.18	100.90	1.07	.547	-1.84	.066
Foot Length	269.08	269.74	1.03	.746	-0.70	.483
Sitting Height	924.64	917.44	1.11	.319	2.86	**.004***
Head Circ	568.80	568.8025	1.04	.693	0.56	.574
Menton-Sellion	122.09	121.9534	1.06	.555	0.29	.774

Table 24. T-test Results Comparing Means of USMC Male Sample and Race/Age/Weight Match

*significantly different means at $p \leq .05$ using a Bonferroni correction for multiple comparisons

USMC Female Matched Database Validation

1. Truncation Using USMC Weight for Height Standards

Table 25 presents the Weight for Height retention standards for USMC females[4]. When the measured USMC female sample was compared to these standards, it was found that most of the female Marines met all of the standards for Height and minimum Weight for Height. A total of three subjects (413, 657, 659) did not meet the minimum Weight requirement for their Height, but in each case the individual was no more than 1.5 pounds below the minimum requirement. Since Weight can easily fluctuate by 1.5 pounds during the course of a single day, these individuals were not considered in violation of the standards. However, since 204 (42.5%) of the measured subjects exceed the maximum weight standards, the maximum allowable weight limit was not used for truncation. Only the Height and minimum Weight requirements were used to truncate the ANSUR female database prior to matching. After truncation, a total of 3446 subjects were still available for matching.

Table 25. Height and Weight Retention Standards for Female USMC Personnel (MCO P6100.3H)		
	Female Weight Standards	
Height (in)	Minimum (lb)	Maximum (lb)
58*	90	121
59	92	123
60	94	125
61	95	127
62	98	130
63	100	134
64	102	138
65	104	142
66	106	147
67	109	151
68	112	156
69	115	160
70	118	165
71	122	170
72	125	175

*Measurements of 0.5 inches or more are rounded up to the next higher inch and measurements of less than 0.5 inches are rounded down. Each height category is actually a range, so 58 inches is the range 57.5 to 58.5 inches.

2. Demographic Only (Race/Age) Matching

The demographic distribution of the truncated ANSUR female database is presented in Table 26. The weighting factors in Table 27 were used to weight the entire truncated database to have the same demographic distribution of both the weighted female USMC validation sample and the February 1995 USMC female population. The weights were calculated by dividing the number of desired subjects in each age/race cell (Table 12) by the number of available ANSUR subjects (Table 26).

As shown in Table 28, the female Marines have significantly larger Chest Circumferences, smaller Waist Circumferences, taller Sitting Heights, larger Foot Breadths, and larger Head Circumferences on average when compared to the Race/Age matched database. The summary statistics in Appendix C also show that the USMC female distribution for Stature tends to be slightly taller and the distribution for Weight is slightly heavier throughout most of the percentile ranges. Because this matching procedure failed to control both mass related dimensions and linear dimensions, other matching procedures were tested in which Weight and/or Stature were controlled in addition to race and age.

Table 26. Demographic Distribution of Truncated ANSUR Female Database

	White	Black	Hispanic	Asian/Pa Islander	American Indian	Mixed/ Other
≤ 20	315	294	52	21	10	51
21-24	361	336	103	29	19	70
25-30	350	398	103	41	10	57
≥ 31	337	329	67	40	9	44

Table 27. Demographic Only Match Weighting Factors for Truncated ANSUR Females

	White	Black	Hispanic	Asian/Pa Islander	American Indian	Mixed/ Other
≤ 20	0.1873	0.0578	0.2308	0.0000	0.2000	0.0196
21-24	0.1800	0.0744	0.1165	0.1034	0.1053	0.0286
25-30	0.1114	0.0528	0.0582	0.0000	0.1000	0.0351
≥ 31	0.1306	0.0699	0.0896	0.0250	0.0000	0.0227

	USMC Female Mean	Matched Mean	F	p	t	p
Stature	1630.8277	1626.0861	1.10	.400	1.00	.318
Weight	619.5008	614.3561	1.04	.708	0.84	.400
Waist Height	984.0797	977.6284	1.08	.496	1.78	.076
Sleeve	548.4028	543.1187	1.04	.709	2.34	.020
Chest Circ	925.6960	907.9307	1.08	.486	3.81	**.000***
Waist Circ	755.3844	792.3123	1.34	.007	-2.96	**.003***
Buttock Circ	972.9844	964.6738	1.01	.963	1.86	.064
Foot Breadth	90.7859	89.2166	1.07	.557	4.24	**.000***
Foot Length	242.7462	242.7064	1.02	.889	0.04	.965
Sitting Height	866.8001	854.7612	1.23	.055	4.86	**.000***
Head Circ	552.8178	544.8102	1.08	.481	7.10	**.000***
Menton-Sellion	112.7916	113.0622	1.03	.771	-0.59	.555

Table 28. T-test Results Comparing Means of USMC Female Sample and Race/Age Match

*significantly different means at $p \leq .05$ using a Bonferroni correction for multiple comparisons

3. Race/Age/Weight Matching

First, the USMC sample was divided into thirds using the 33.3% (582) and the 66.6% (651) values for Weight. As shown in Table 29, the demographic distribution of the USMC sample was determined for each of the Weight ranges. Table 30 presents the demographic distribution of the ANSUR female data set in each of the Weight categories and weighting factors were determined for each of the Race/Age/Weight cells (see Table 31). A total of 3201 subjects were available for use in the matching process.

While including Weight as one of the factors in the matching process did improve the results, the same dimensions continue to show significant differences between the means (see Table 32). For this reason, a third matching process was tested based on race, age and Height.

Table 29.	Demographically Representative Sample Divided into Three Weight Groups Using Percentiles						
	White	Black	Hispanic	Asian/Pacific Islander	American Indian	Mixed/ Other	Total
Weight < 33.3% (582)							
$\leq$ 20	15	4	6	0	1	0	26
21-24	25	9	6	2	1	0	43
25-30	11	5	2	0	0	1	19
$\geq$ 31	15	4	2	0	0	1	22
Weight 33.3% to 66.6% (582 - 651)							
$\leq$ 20	18	8	4	0	1	1	32
21-24	24	10	3	0	1	1	39
25-30	11	5	2	0	1	1	20
$\geq$ 31	16	9	2	1	0	0	28
Weight > 66.6% (651)							
$\leq$ 20	26	5	2	0	0	0	33
21-24	16	6	3	1	0	1	27
25-30	17	11	2	0	0	0	30
$\geq$ 31	13	10	2	0	0	0	25
Total	207	86	36	4	5	6	344

Table 30.	Distribution of Truncated ANSUR Females in Three Weight Groups						
	White	Black	Hispanic	Asian/Pacific Islander	American Indian	Mixed/ Other	Total
Weight < 33.3% (582)							
≤ 20	118	123	35	10	4	31	321
21-24	136	132	47	20	5	32	372
25-30	108	112	43	23	3	17	306
≥ 31	101	71	22	17	3	10	224
Weight 33.3% to 66.6% (582 - 651)							
≤ 20	133	113	13	3	1	14	277
21-24	126	119	42	7	4	21	319
25-30	129	144	29	10	4	22	338
≥ 31	93	102	32	15	4	12	258
Weight > 66.6% (651)							
≤ 20	64	58	4	8	5	6	145
21-24	99	85	14	2	10	17	227
25-30	113	142	31	8	3	18	315
≥ 31	143	156	13	8	2	22	344
Total	1363	1357	325	131	48	222	3446

Table 31. Race/Age/Weight Match Weighting Factors for Truncated ANSUR Females in Three Weight Groups						
	White	Black	Hispanic	Asian/Pa Islander	American Indian	Mixed/ Other
Weight < 33.3% (744.929)						
≤ 20	0.127119	0.032520	0.171428	0.000000	0.250000	0.000000
21-24	0.183824	0.068182	0.127660	0.100000	0.200000	0.000000
25-30	0.101852	0.044643	0.046512	0.000000	0.000000	0.058824
≥ 31	0.148515	0.056338	0.090909	0.000000	0.000000	0.100000
Weight 33.3% to 66.6% (744.929 - 830.000)						
≤ 20	0.135338	0.070796	0.307692	0.000000	1.000000	0.071428
21-24	0.190476	0.084034	0.071428	0.000000	0.250000	0.047619
25-30	0.085271	0.034722	0.068966	0.000000	0.250000	0.045454
≥ 31	0.172043	0.088235	0.062500	0.066667	0.000000	0.000000
Weight > 66.6% (830.000)						
≤ 20	0.406250	0.086207	0.500000	0.000000	0.000000	0.000000
21-24	0.161616	0.070588	0.214286	0.500000	0.000000	0.058824
25-30	0.150442	0.077465	0.064516	0.000000	0.000000	0.000000
≥ 31	0.090909	0.064102	0.153846	0.000000	0.000000	0.000000

	USMC Female Mean	Matched Mean	F	p	t	p
Table 32. T-test Results Comparing Means of USMC Female Sample and Race/Age/Weight Match						
Stature	1630.8277	1629.5349	1.10	.392	0.27	.785
Weight	619.5008	620.6317	1.01	.896	-0.19	.852
Waist Height	984.0797	980.1906	1.09	.402	1.07	.286
Sleeve	548.4028	544.6413	1.04	.728	1.66	.096
Chest Circ	925.6960	911.1602	1.05	.636	3.14	**.002***
Waist Circ	775.3844	796.4154	1.29	.020	-3.72	**.000***
Buttock Circ	972.9844	969.0532	1.03	.792	0.89	.376
Foot Breadth	90.7859	89.4730	1.07	.559	3.55	**.000***
Foot Length	242.7462	243.3648	1.01	.920	-0.68	.499
Sitting Height	866.8001	856.2603	1.22	.068	4.26	**.000***
Head Circ	552.8178	545.2025	1.08	.465	6.76	**.000***
Menton-Sellion	112.7916	113.2813	1.04	.741	-1.07	.285

*significantly different means at $p \leq .05$ using a Bonferroni correction for multiple comparisons

4. Race/Age/Height Matching

The height distribution of the USMC female sample was divided into thirds using the 33.3% (1605.389) and the 66.6% (1655.646) values for Stature. As shown in Table 33, the demographic distribution of the USMC sample was determined for each of the Height ranges. Table 34 presents the demographic distribution of the ANSUR female data set in each of the Height categories, and the calculated weighting factors for the Race/Age/Height cells are presented in Table 35. A total of 3192 subjects were retained in the matching process.

As with the Race/Age/Weight matching, the means for Chest Circumference, Waist Circumference, Foot Breadth, Sitting Height, and Head Circumference remain significantly different (see Table 36). Although the difference between the means did decrease slightly for several dimensions (Waist Circumference, Sitting Height, Head Circumference), it also increased slightly for two dimensions (Chest Circumference, Foot Breadth). As shown in Appendix C, the ability of the matched database to accurately produce percentiles that emulate that of the measured female USMC sample for Chest

Circumference and Buttock Circumference was compromised. Therefore, a fourth matching method was examined based on demographics, Weight, and Height.

Table 33.	Demographically Representative Sample Divided into Three Height Groups Using Percentiles						
	White	Black	Hispanic	Asian/Pa Islander	American Indian	Mixed/ Other	Total
Height < 33.3% (1605.389)							
≤ 20	22	5	7	0	0	0	34
21-24	20	6	5	2	1	0	34
25-30	11	7	3	0	0	1	22
≥ 31	13	7	3	0	0	0	23
Height 33.3% to 66.6% (1605.389-1655.646)							
≤ 20	19	7	4	0	2	0	32
21-24	26	8	5	0	0	1	40
25-30	10	6	2	0	1	0	19
≥ 31	14	6	2	1	0	1	24
Height > 66.6% (1655.646)							
≤ 20	18	5	1	0	0	1	25
21-24	19	11	2	1	1	1	35
25-30	18	8	1	0	0	1	28
≥ 31	17	10	1	0	0	0	28
Total	207	84	36	4	5	6	344

Table 34. Demographic Distribution of Truncated ANSUR Females in Three Height Groups							
	White	Black	Hispanic	Asian/Pa Islander	American Indian	Mixed/ Other	Total
Height < 33.3% (1605.389)							
≤ 20	122	107	40	9	4	29	311
21-24	129	121	56	20	7	37	370
25-30	110	140	62	28	3	27	370
≥ 31	107	119	49	30	1	19	325
Height 33.3% to 66.6% (1605.389-1655.646)							
≤ 20	97	93	7	7	4	12	220
21-24	96	106	24	7	7	14	254
25-30	99	128	30	7	5	16	285
≥ 31	120	94	10	6	7	14	251
Height > 66.6% (1655.646)							
≤ 20	96	94	5	5	2	10	212
21-24	136	109	23	2	5	19	294
25-30	141	130	11	6	2	14	304
≥ 31	110	116	8	4	1	11	250
Total	1363	1357	325	131	48	222	3446

Table 35. Race/Age/Height Match Weighting Factors for Truncated ANSUR Females in Three Height Groups						
	White	Black	Hispanic	Asian/Pa Islander	American Indian	Mixed/ Other
Height < 33.3% (1605.389)						
≤ 20	0.180328	0.046729	0.175000	0.000000	0.000000	0.000000
21-24	0.155039	0.049587	0.089286	0.100000	0.142857	0.000000
25-30	0.100000	0.050000	0.048387	0.000000	0.000000	0.037037
≥ 31	0.121495	0.058824	0.061224	0.000000	0.000000	0.000000
Height 33.3% to 66.6% (1605.389-1655.646)						
≤ 20	0.195876	0.075269	0.571429	0.000000	0.200000	0.000000
21-24	0.270833	0.075472	0.208333	0.000000	0.000000	0.071428
25-30	0.101010	0.046875	0.066667	0.000000	0.200000	0.000000
≥ 31	0.116667	0.063830	0.200000	0.166667	0.000000	0.071428
Height > 66.6% (1655.646)						
≤ 20	0.187500	0.053191	0.200000	0.000000	0.000000	0.100000
21-24	0.139706	0.100917	0.086956	0.500000	0.200000	0.052632
25-30	0.127660	0.061538	0.090909	0.000000	0.000000	0.071428
≥ 31	0.154545	0.086207	0.125000	0.000000	0.000000	0.000000

	USMC Female Mean	Matched Mean	F	p	t	p
Table 36. T-test Results Comparing Means of USMC Female Sample and Race/Age/Height Match						
Stature	1630.8277	1631.7452	1.04	.739	-0.20	.845
Weight	619.5008	617.9488	1.05	.621	0.25	.800
Waist Height	984.0797	981.5462	1.04	.742	0.70	.481
Sleeve	548.4028	545.1317	1.05	.675	1.45	.148
Chest Circ	925.6960	909.0363	1.09	.438	3.56	**.000***
Waist Circ	775.3844	793.4000	1.34	.007	-3.15	**.002***
Buttock Circ	972.9844	966.5574	1.02	.891	1.43	.153
Foot Breadth	90.7859	89.4015	1.05	.641	3.73	**.000***
Foot Length	242.7462	243.4596	1.02	.829	-0.78	.434
Sitting Height	866.8001	857.2055	1.16	.159	3.93	**.000***
Head Circ	552.8178	545.2779	1.06	.571	6.66	**.000***
Menton-Sellion	112.7916	113.2164	1.02	.838	-0.92	.355

*significantly different means at $p \leq .05$ using a Bonferroni correction for multiple comparisons

5. Race/Age/Height/Weight Matching

The Height and Weight distributions of the USMC female sample were divided into thirds using the 33.3% (Height=1605.389, Weight=744.929) and the 66.6% (Height=1655.646, Weight=830.000) values. As shown in Table 37, the demographic distribution of the USMC sample was determined for each of the 9 Height/Weight cells. Table 38 presents the demographic distribution of the ANSUR female data set in each of the Height/Weight groups, and the weighting factors for each of the cells are presented in Table 39. A total of 2888 subjects were retained in this matching procedure.

When the matched database means are compared to those of the measured USMC female sample, statistically significant differences are present for five of the dimensions (Chest Circumference, Waist Circumference, Foot Breadth, Sitting Height, and Head Circumference). For Waist Circumference, the variances in the two data sets are not equal, making the t-test an invalid test. When the female USMC data are compared to the matched database using a nonparametric test (Mann-Whitney U) that is not sensitive to differences in the variances, then the results indicate that, in fact, the Waist Circumference means are *not* significantly different (p = .06) from each other. When the combined

interobserver error rates of the female USMC data set and the ANSUR database are considered, then only Head Circumference continues to be significantly different (see Table 41).

The magnitude of the differences in means for any of the dimensions considered, however, are not large enough to impact the development of CIE or workstations. In addition, this matching procedure produces the smallest differences overall for both means and percentiles of all the matching procedures investigated. The application of the weighting factors presented in Table 39 to the truncated female ANSUR database yields a database that can be used to accurately estimate the anthropometry of the current USMC female population.

Table 37. Demographically Representative Sample Divided into Nine Height/Weight Groups Using Percentiles

	Height < 33.3%						Height 33.3% to 66.6%						Height > 66.6%						
	W*	B	H	AP	AI	MO	W	B	H	AP	AI	MO	W	B	H	AP	AI	MO	Total
Weight < 33.3%																			
≤ 20	13	4	5	0	0	0	2	0	1	0	0	0	1	0	0	0	0	0	26
21-24	12	3	3	2	1	0	10	3	3	0	0	0	3	3	0	1	1	0	45
25-30	6	2	1	0	0	0	4	2	1	0	0	1	1	1	0	0	0	0	19
≥ 31	7	3	2	0	0	1	6	0	0	0	0	0	2	1	0	0	0	0	22
Weight 33.3% to 66.6%																			
≤ 20	7	1	2	0	0	0	8	4	2	0	0	1	3	3	0	0	0	0	31
21-24	7	2	2	0	0	0	10	4	0	0	0	1	7	4	1	0	1	0	39
25-30	4	3	1	0	0	0	3	0	0	0	0	0	4	2	1	0	1	0	19
≥ 31	4	4	0	0	0	0	4	4	1	0	0	0	7	1	1	0	0	0	26
Weight > 66.6%																			
≤ 20	2	1	0	0	0	0	10	2	1	0	0	0	14	2	1	0	0	0	33
21-24	2	1	0	0	0	0	6	1	2	1	0	0	8	4	1	0	0	1	27
25-30	1	1	1	0	0	0	3	5	1	0	0	0	13	5	0	0	1	0	31
≥ 31	2	0	1	0	0	0	4	2	1	0	0	1	7	8	0	0	0	0	26
Total	67	25	18	2	1	1	70	27	13	1	0	4	70	34	5	1	4	1	344

*W=White; B=Black; H=Hispanic; AP=Asian/Pacific Islander; AI=American Indian; MO=Mixed/Other

Table 38.	Demographic Distribution of Truncated ANSUR Females in Nine Height/Weight Groups																		

	Height < 33.3%						Height 33.3% to 66.6%						Height > 66.6%						
	W*	B	H	AP	AI	MO	W	B	H	AP	AI	MO	W	B	H	AP	AI	MO	Total
Weight < 33.3%																			
≤ 20	73	69	30	9	3	24	29	35	5	1	1	4	16	19	0	0	0	3	321
21-24	72	68	33	17	3	24	37	45	10	2	2	6	27	19	4	1	0	2	372
25-30	56	67	35	22	2	16	32	34	7	1	1	1	20	11	1	0	0	0	306
≥ 31	62	43	21	16	1	9	31	17	1	0	2	1	8	11	0	1	0	0	224
Weight 33.3% to 66.6%																			
≤ 20	39	32	9	0	1	4	53	41	1	3	0	6	41	40	3	0	0	4	277
21-24	38	38	20	3	2	12	38	44	12	4	1	4	50	37	10	0	1	5	319
25-30	35	50	17	5	1	9	44	55	8	4	3	10	50	39	4	1	0	3	338
≥ 31	28	47	24	11	0	5	37	34	4	3	4	6	28	21	4	1	0	1	258
Weight > 66.6%																			
≤ 20	10	6	1	0	0	1	15	17	1	3	3	2	39	35	2	5	2	3	145
21-24	19	15	3	0	2	1	21	17	2	1	4	4	59	53	9	1	4	12	227
25-30	19	23	10	1	0	2	23	39	15	2	1	5	71	80	6	5	2	11	315
≥ 31	17	29	4	3	0	5	52	43	5	3	1	7	74	84	4	2	1	10	344
Total	468	487	207	87	15	112	412	421	71	27	23	56	483	449	47	17	10	54	3446

*W=White; B=Black; H=Hispanic; AP=Asian/Pacific Islander; AI=American Indian; MO=Mixed/Other

Table 39. Race/Age/Height/Weight Match Weighting Factors for Truncated ANSUR Females in Height/Weight Groups

	White	Black	Hispanic	Asian/Pa Islander	American Indian	Mixed/ Other
Weight < 33.3% and Height < 33.3%						
≤ 20	0.178082	0.057971	0.166667	0.000000	0.000000	0.000000
21-24	0.166667	0.044118	0.090909	0.117647	0.333333	0.000000
25-30	0.107143	0.029851	0.028571	0.000000	0.000000	0.000000
≥ 31	0.112903	0.069767	0.095238	0.000000	0.000000	0.111111
Weight < 33.3% and Height 33.3% to 66.6%						
≤ 20	0.068966	0.000000	0.200000	0.000000	0.000000	0.000000
21-24	0.270270	0.066667	0.300000	0.000000	0.000000	0.000000
25-30	0.125000	0.058824	0.142857	0.000000	0.000000	1.000000
≥ 31	0.193548	0.000000	0.000000	0.000000	0.000000	0.000000
Weight < 33.3% and Height > 66.6%						
≤ 20	0.062500	0.000000	0.000000	0.000000	0.000000	0.000000
21-24	0.111111	0.157895	0.000000	1.000000	0.000000	0.000000
25-30	0.050000	0.090909	0.000000	0.000000	0.000000	0.000000
≥ 31	0.250000	0.090909	0.000000	0.000000	0.000000	0.000000
Weight 33.3% to 66.6% and Height < 33.3%						
≤ 20	0.179487	0.031250	0.222222	0.000000	0.000000	0.000000
21-24	0.184211	0.052632	0.100000	0.000000	0.000000	0.000000
25-30	0.114286	0.060000	0.058824	0.000000	0.000000	0.000000
≥ 31	0.142857	0.085106	0.000000	0.000000	0.000000	0.000000
Weight 33.3% to 66.6% and Height 33.3% to 66.6%						
≤ 20	0.150943	0.097561	2.000000	0.000000	0.000000	0.166667
21-24	0.263158	0.090909	0.000000	0.000000	0.500000	0.250000
25-30	0.068182	0.000000	0.000000	0.000000	0.000000	0.000000
≥ 31	0.108108	0.117647	0.250000	0.000000	0.000000	0.000000
Weight 33.3% to 66.6% and Height > 66.6%						
≤ 20	0.073171	0.075000	0.000000	0.000000	0.000000	0.000000
21-24	0.140000	0.108108	0.100000	0.000000	1.000000	0.000000
25-30	0.080000	0.051282	0.250000	0.000000	0.000000	0.000000
≥ 31	0.250000	0.047619	0.250000	0.000000	0.000000	0.000000

	White	Black	Hispanic	Asian/Pa Islander	American Indian	Mixed/ Other
Table 39. (Cont.) Race/Age/Height/Weight Match Weighting Factors for Truncated ANSUR Females in Height/Weight Groups						

Table 39. (Cont.) Race/Age/Height/Weight Match Weighting Factors for Truncated ANSUR Females in Height/Weight Groups

	White	Black	Hispanic	Asian/Pa Islander	American Indian	Mixed/ Other
Weight > 66.6% and Height < 33.3%						
≤ 20	0.200000	0.166667	0.000000	0.000000	0.000000	0.000000
21-24	0.105263	0.066667	0.000000	0.000000	0.000000	0.000000
25-30	0.052632	0.043478	0.100000	0.000000	0.000000	0.000000
≥ 31	0.117647	0.000000	0.250000	0.000000	0.000000	0.000000
Weight > 66.6% and Height 33.3% to 66.6%						
≤ 20	0.666667	0.117647	1.000000	0.000000	0.000000	0.000000
21-24	0.285714	0.058824	1.000000	1.000000	0.000000	0.000000
25-30	0.130435	0.128205	0.066667	0.000000	0.000000	0.000000
≥ 31	0.076923	0.046512	0.200000	0.000000	0.000000	0.142857
Weight > 66.6% and Height > 66.6%						
≤ 20	0.358974	0.057143	0.500000	0.000000	0.000000	0.000000
21-24	0.135593	0.075472	0.111111	0.000000	0.000000	0.083333
25-30	0.183099	0.062500	0.000000	0.000000	0.500000	0.000000
≥ 31	0.094595	0.095238	0.000000	0.000000	0.000000	0.000000

Table 40. T-test Results Comparing Means of USMC Female Sample and Race/Age/Height/Weight Match

	USMC Female Mean	Race/Age Match Mean	F	p	t	p
Stature	1630.8277	1631.5159	1.04	.722	-0.15	.883
Weight	619.5008	621.8234	1.06	.583	-0.38	.706
Waist Height	984.0797	981.6568	1.03	.762	0.67	.500
Sleeve	548.4028	545.3254	1.05	.680	1.36	.173
Chest Circ	925.6960	911.3294	1.09	.411	3.07	**.002***
Waist Circ	775.3844	795.6203	1.31	.014	-3.56	**.000***
Buttock Circ	972.9844	969.0142	1.00	.977	0.89	.375
Foot Breadth	90.7859	89.5170	1.04	.686	3.41	**.001***
Foot Length	242.7462	243.6255	1.01	.926	-0.96	.337
Sitting Height	866.8001	857.2196	1.17	.147	3.91	**.000***
Head Circ	552.8178	545.4959	1.07	.554	6.47	**.000***
Menton-Sellion	112.7916	113.3123	1.04	.697	-1.14	.255

*significantly different means at $p \leq .05$ using a Bonferroni correction for multiple comparisons

Table 41. T-test Results Adjusted for Interobserver Error Comparing Means of USMC Female Sample and Race/Age/Height/Weight Match

	USMC Female Mean	Race/Age Match Mean	F	p	t	p
Chest Circ	925.6960	923.5494	1.09	.411	0.46	.647
Foot Breadth	90.7859	91.0770	1.04	.686	-0.78	.434
Sitting Height	866.8001	861.9896	1.17	.147	1.97	.050
Head Circ	552.8178	549.6859	1.07	.554	2.77	**.006***

*significantly different means at $p \leq .05$ using a Bonferroni correction for multiple comparisons

References

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4. Marine Corps Order P6100.3H

APPENDICES

Appendix A
Resampling Stats Program for Interobserver Error Analysis

Appendix A
Resampling Stats Program for Interobserver Error Analysis

The following is a Resampling Stats program to test directionality for Menton-Sellion Length interobserver error data collected on females during the USMC validation study.

```
'What is the probability that M1 measured larger 4 of 12 attempts, with 1 tie,
'for the female sample (Menton-Sellion Length), given that a total of 487
'female subjects were measured during the study?


'Create a vector with 488 observations in which M1 measured larger 244 times
'(value is 1) and M2 measured larger 244 times (value is 2)
CONCAT 244#1 244#2 VAR
MAXSIZE X 10000
MAXSIZE Y 10000
REPEAT 10000
        SHUFFLE VAR A
'Take 12 test-retest samples from all subjects measured
        SAMPLE 12 A B
'Count the number of times M1 measured larger
        COUNT B = 1 C
'Calculate the percentage of times M1 measured larger
        DIVIDE C 12 D
        SCORE D X
        END
COUNT X <= .3333 Y
DIVIDE Y 10000 Z
PRINT Z
'Z equals the probability of observing M1 measuring larger than M2 in 4 out of 12
'attempts from a random sample of 12 drawn from 488 possible remeasures in a
'universe where 50% of the time M1 measures larger and 50% of the time M2
'measures larger
```

APPENDIX B
Male Matching Results: Summary Statistics

APPENDIX B
Male Matching Results: Summary Statistics

Stature

	USMC Males	Race/Age Match	USMC-Race/ Age Match	Race/Age/Wt Match	USMC-Race/ Age/Wt Match
	n=493	n=5103		n=4447	
Mean	1757.97	1754.66	3.31	1759.03	-1.06
St Dev	66.44	67.24	-0.80	66.52	-0.08
Min	1558.00	1513.00	45.00	1513.00	45.00
Max	1912.00	1980.00	-68.00	1980.00	-68.00
%					
1st	1597.65	1600.03	-2.38	1608.13	-10.48
2nd	1627.36	1617.22	10.14	1624.01	3.35
3rd	1635.66	1627.27	8.38	1632.42	3.23
5th	1651.00	1643.67	7.33	1650.41	0.59
10th	1674.00	1669.54	4.46	1673.40	0.60
15th	1690.59	1685.00	5.59	1690.13	0.47
20th	1705.00	1689.38	15.62	1702.00	3.00
25th	1713.00	1708.00	5.00	1713.00	0.00
30th	1722.00	1718.00	4.00	1723.00	-1.00
35th	1729.00	1727.00	2.00	1732.00	-3.00
40th	1735.00	1736.00	-1.00	1742.00	-7.00
45th	1745.00	1745.99	-0.99	1751.00	-6.00
50th	1755.97	1755.00	0.97	1759.26	-3.29
55th	1766.00	1762.94	3.06	1766.34	-0.34
60th	1774.00	1771.00	3.00	1775.00	-1.00
65th	1785.00	1780.91	4.09	1785.00	0.00
70th	1795.00	1790.14	4.86	1794.58	0.42
75th	1805.21	1800.00	5.21	1804.76	0.45
80th	1819.00	1812.00	7.00	1816.29	2.71
85th	1830.00	1825.04	4.96	1829.98	0.03
90th	1847.52	1842.00	5.52	1845.07	2.44
95th	1874.59	1868.34	6.25	1869.75	4.83
97th	1883.00	1881.41	1.59	1884.16	-1.16
98th	1894.14	1894.34	-0.20	1897.01	-2.87
99th	1906.09	1915.27	-9.18	1918.06	-11.97

Weight

	USMC Males	Race/Age Match	USMC-Race/Age Match	Race/Age/Wt Match	USMC-Race/Age/Wt Match
	n=493	n=5103		n=4447	
Mean	790.90	778.18	12.72	790.66	0.25
St Dev	100.72	107.89	-7.18	106.13	-5.41
Min	533.00	476.00	57.00	476.00	57.00
Max	1106.00	1333.00	-227.00	1333.00	-227.00
%					
1st	564.01	560.01	4.00	568.42	-4.41
2nd	590.11	585.20	4.92	595.09	-4.98
3rd	604.00	598.04	5.97	607.01	-3.01
5th	618.50	616.25	2.24	625.38	-6.89
10th	663.81	646.38	17.43	655.11	8.70
15th	689.05	666.48	22.57	679.87	9.19
20th	707.64	686.30	21.34	702.03	5.61
25th	723.00	704.00	19.00	716.84	6.16
30th	737.00	716.00	21.00	736.25	0.75
35th	747.00	731.58	15.42	750.00	-3.00
40th	763.00	743.54	19.46	761.37	1.63
45th	775.47	757.00	18.47	773.00	2.47
50th	791.97	770.21	21.76	785.00	6.97
55th	804.00	784.00	20.00	796.88	7.12
60th	816.88	796.81	20.07	810.00	6.88
65th	827.01	811.99	15.02	824.14	2.88
70th	837.15	826.89	10.26	839.00	-1.85
75th	860.13	843.66	16.47	854.00	6.13
80th	879.61	863.31	16.31	875.71	3.90
85th	898.58	887.87	10.71	895.22	3.35
90th	926.65	918.28	8.37	926.68	-0.03
95th	953.69	977.16	-23.47	984.53	-30.83
97th	989.57	1011.14	-21.58	1013.30	-23.74
98th	996.55	1037.21	-40.66	1039.15	-42.60
99th	1025.45	1082.23	-56.78	1082.20	-56.75

Waist Height (Omphalion)

	USMC Males	Race/Age Match	USMC-Race/ Age Match	Race/Age/Wt Match	USMC-Race/ Age/Wt Match
	n=493	n=5103		n=4447	
Mean	1061.15	1057.09	4.06	1060.02	1.14
St Dev	50.44	51.05	-0.60	50.55	-0.11
Min	886.00	861.00	25.00	861.00	25.00
Max	1213.00	1254.00	-41.00	1254.00	-41.00
%					
1st	937.55	937.30	0.25	941.21	-3.66
2nd	959.57	951.81	7.76	956.17	3.40
3rd	969.00	961.41	7.59	963.36	5.64
5th	979.76	973.34	6.42	977.20	2.56
10th	998.00	991.00	7.00	994.85	3.15
15th	1009.93	1005.00	4.93	1007.94	1.99
20th	1017.00	1015.00	2.00	1018.00	-1.00
25th	1026.48	1023.06	3.42	1027.00	-0.52
30th	1032.11	1031.00	1.11	1034.00	-1.89
35th	1040.91	1037.00	3.91	1040.00	0.91
40th	1049.00	1043.76	5.24	1046.00	3.00
45th	1054.00	1050.00	4.00	1054.00	0.00
50th	1061.00	1057.00	4.00	1060.00	1.00
55th	1068.00	1063.00	5.00	1066.00	2.00
60th	1074.59	1070.00	4.59	1072.94	1.65
65th	1079.00	1076.09	2.91	1078.93	0.07
70th	1087.00	1083.73	3.27	1086.31	0.69
75th	1095.34	1092.00	3.34	1094.00	1.34
80th	1104.29	1100.00	4.29	1102.70	1.59
85th	1115.29	1110.00	5.29	1112.00	3.29
90th	1128.61	1122.70	5.91	1125.00	3.61
95th	1146.14	1142.77	3.37	1144.29	1.85
97th	1154.48	1153.40	1.08	1154.65	-0.16
98th	1164.06	1163.32	0.74	1164.55	-0.49
99th	1178.45	1179.15	-0.71	1179.32	-0.87

Sleeve Outseam

	USMC Males	Race/Age Match	USMC-Race/ Age Match	Race/Age/Wt Match	USMC-Race/ Age/Wt Match
	n=493	n=5103		n=4447	
Mean	594.98	599.36	-4.37	601.13	-6.14
St Dev	30.43	30.25	0.18	30.00	0.43
Min	510.00	480.00	30.00	480.00	30.00
Max	710.00	715.00	-5.00	715.00	-5.00
%					
1st	520.04	531.30	-11.27	533.15	-13.12
2nd	537.43	539.30	-1.87	540.52	-3.08
3rd	540.00	542.76	-2.76	544.00	-4.00
5th	547.79	549.92	-2.13	552.00	-4.21
10th	556.43	561.00	-4.57	562.18	-5.75
15th	565.00	568.00	-3.00	570.00	-5.00
20th	570.00	573.83	-3.83	575.59	-5.59
25th	573.00	579.00	-6.00	581.00	-8.00
30th	578.00	583.00	-5.00	585.00	-7.00
35th	580.00	588.00	-8.00	590.00	-10.00
40th	585.00	591.28	-6.28	593.00	-8.00
45th	590.00	595.00	-5.00	597.00	-7.00
50th	594.00	599.00	-5.00	601.00	-7.00
55th	599.00	602.00	-3.00	604.00	-5.00
60th	603.11	606.00	-2.89	608.00	-4.89
65th	607.00	611.00	-4.00	612.00	-5.00
70th	611.58	615.00	-3.42	617.00	-5.42
75th	615.00	620.00	-5.00	622.00	-7.00
80th	620.62	625.22	-4.60	626.65	-6.03
85th	627.89	631.00	-3.11	632.22	-4.32
90th	635.00	638.00	-3.00	640.00	-5.00
95th	645.00	649.67	-4.67	650.33	-5.33
97th	650.00	658.16	-8.16	659.12	-9.12
98th	655.00	665.29	-10.29	666.12	-11.12
99th	674.88	674.24	0.64	674.41	0.47

Chest Circumference

	USMC Males	Race/Age Match	USMC-Race/ Age Match	Race/Age/Wt Match	USMC-Race/ Age/Wt Match
	n=493	n=5103		n=4447	
Mean	1009.81	989.21	20.60	996.19	13.61
St Dev	71.89	67.62	4.27	67.01	4.88
Min	817.00	775.00	42.00	775.00	42.00
Max	1208.00	1330.00	-122.00	1330.00	-122.00
%					
1st	843.90	851.44	-7.53	854.13	-10.23
2nd	863.24	865.08	-1.84	871.21	-7.97
3rd	874.53	874.60	-0.07	877.53	-2.99
5th	894.00	886.62	7.38	891.78	2.22
10th	915.88	904.25	11.63	911.97	3.91
15th	930.69	919.00	11.69	926.50	4.19
20th	945.00	931.00	14.00	939.00	6.00
25th	960.20	942.38	17.82	950.24	9.96
30th	971.39	952.00	19.39	959.00	12.39
35th	981.22	959.91	21.31	968.00	13.22
40th	990.38	968.00	22.38	976.59	13.79
45th	1000.00	976.00	24.00	986.00	14.00
50th	1009.30	985.67	23.63	993.00	16.30
55th	1017.41	993.00	24.41	1002.00	15.41
60th	1030.36	1002.73	27.63	1009.00	21.36
65th	1040.00	1010.78	29.22	1019.00	21.00
70th	1050.29	1021.00	29.29	1029.00	21.29
75th	1062.00	1032.54	29.46	1038.83	23.17
80th	1073.47	1044.00	29.47	1048.77	24.71
85th	1089.08	1057.00	32.08	1062.83	26.25
90th	1102.00	1077.45	24.55	1083.48	18.52
95th	1130.00	1111.20	18.80	1115.78	14.22
97th	1140.00	1129.54	10.46	1132.02	7.98
98th	1149.76	1147.10	2.66	1148.25	1.51
99th	1167.18	1174.03	-6.85	1173.12	-5.94

Waist Circumference (Omphalion)

	USMC Males	Race/Age Match	USMC-Race/ Age Match	Race/Age/Wt Match	USMC-Race/ Age/Wt Match
	n=493	n=5103		n=4447	
Mean	872.05	858.17	13.89	866.60	5.45
St Dev	82.63	84.93	-2.30	84.84	-2.21
Min	690.00	640.00	50.00	650.00	40.00
Max	1102.00	1281.00	-179.00	1281.00	-179.00
%					
1st	703.31	703.10	0.20	706.11	-2.80
2nd	721.00	713.47	7.53	718.01	2.99
3rd	725.71	724.40	1.31	728.20	-2.49
5th	745.22	736.34	8.88	741.73	3.50
10th	761.77	754.91	6.86	761.56	0.21
15th	783.20	770.27	12.93	775.85	7.34
20th	791.88	782.00	9.88	789.78	2.10
25th	807.00	794.40	12.60	802.94	4.06
30th	822.18	805.00	17.18	814.00	8.18
35th	835.00	816.00	19.00	826.56	8.44
40th	848.00	827.65	20.35	837.00	11.00
45th	856.37	838.00	18.37	848.89	7.48
50th	867.50	849.08	18.42	860.27	7.23
55th	876.00	860.72	15.28	870.14	5.86
60th	894.00	871.15	22.85	882.00	12.00
65th	905.77	883.00	22.77	894.69	11.08
70th	922.00	897.28	24.72	909.04	12.96
75th	934.21	914.00	20.21	923.00	11.21
80th	949.93	930.28	19.65	940.32	9.61
85th	967.00	954.69	12.31	961.38	5.62
90th	985.33	977.50	7.83	984.66	0.67
95th	1008.70	1013.36	-4.66	1018.30	-9.60
97th	1030.26	1035.17	-4.91	1039.10	-8.83
98th	1034.20	1049.22	-15.02	1050.08	-15.88
99th	1061.55	1087.05	-25.49	1086.22	-24.67

Buttock Circumference

	USMC Males	Race/Age Match	USMC-Race/ Age Match	Race/Age/Wt Match	USMC-Race/ Age/Wt Match
	n=493	n=5103		n=4447	
Mean	992.04	981.11	10.93	987.83	4.21
St Dev	58.82	60.58	-1.77	59.55	-0.73
Min	837.00	802.00	35.00	808.00	29.00
Max	1160.00	1286.00	-126.00	1286.00	-126.00
%					
1st	860.92	851.14	9.78	856.02	4.89
2nd	875.00	869.28	5.72	873.01	1.99
3rd	882.31	876.27	6.04	881.11	1.19
5th	894.79	888.23	6.56	894.60	0.19
10th	910.70	905.92	4.77	912.34	-1.64
15th	928.13	919.00	9.13	925.00	3.13
20th	942.16	928.00	14.16	936.86	5.30
25th	952.20	938.00	14.20	946.00	6.20
30th	961.00	946.00	15.00	955.00	6.00
35th	968.00	954.00	14.00	962.00	6.00
40th	975.00	961.00	14.00	971.00	4.00
45th	984.00	970.00	14.00	979.53	4.47
50th	992.00	979.00	13.00	986.34	5.66
55th	1000.00	986.00	14.00	993.00	7.00
60th	1009.00	993.34	15.66	1001.00	8.00
65th	1015.00	1002.00	13.00	1009.00	6.00
70th	1023.00	1011.71	11.29	1019.00	4.00
75th	1035.00	1021.75	13.25	1027.00	8.00
80th	1044.50	1032.00	12.50	1038.00	6.50
85th	1058.00	1045.00	13.00	1049.45	8.55
90th	1066.00	1060.78	5.22	1065.00	1.00
95th	1089.00	1084.61	4.39	1088.26	0.74
97th	1100.00	1106.06	-6.06	1108.07	-8.07
98th	1109.14	1119.49	-10.35	1123.02	-13.89
99th	1124.89	1141.07	-16.18	1141.17	-16.27

Foot Breadth

	USMC Males	Race/Age Match	USMC-Race/ Age Match	Race/Age/Wt Match	USMC-Race/ Age/Wt Match
	n=493	n=5103		n=4447	
Mean	100.19	100.56	-0.37	100.90	-0.72
St Dev	5.35	5.18	0.17	5.18	0.17
Min	85.00	80.00	5.00	80.00	5.00
Max	123.00	123.00	0.00	123.00	0.00
%					
1st	89.00	89.00	0.00	89.26	-0.26
2nd	90.00	90.00	0.00	91.00	-1.00
3rd	90.90	91.00	-0.10	92.00	-1.10
5th	91.76	92.00	-0.24	92.29	-0.53
10th	93.00	94.00	-1.00	94.00	-1.00
15th	95.00	95.00	0.00	96.00	-1.00
20th	96.00	96.00	0.00	97.00	-1.00
25th	97.00	97.00	0.00	97.00	0.00
30th	97.00	98.00	-1.00	98.00	-1.00
35th	98.00	98.40	-0.40	99.00	-1.00
40th	99.00	99.00	0.00	100.00	-1.00
45th	99.00	100.00	-1.00	100.00	-1.00
50th	100.00	100.00	0.00	101.00	-1.00
55th	101.00	101.00	0.00	101.00	0.00
60th	101.00	102.00	-1.00	102.00	-1.00
65th	102.00	102.00	0.00	103.00	-1.00
70th	103.00	103.00	0.00	103.00	0.00
75th	104.00	104.00	0.00	104.00	0.00
80th	105.00	105.00	0.00	105.00	0.00
85th	106.00	106.00	0.00	106.00	0.00
90th	107.00	107.00	0.00	108.00	-1.00
95th	109.00	109.78	-0.78	110.00	-1.00
97th	110.00	110.87	-0.87	111.00	-1.00
98th	111.09	112.00	-0.91	112.13	-1.05
99th	114.00	114.22	-0.22	114.95	-0.95

Foot Length

	USMC Males	Race/Age Match	USMC-Race/ Age Match	Race/Age/Wt Match	USMC-Race/ Age/Wt Match
	n=493	n=5103		n=4447	
Mean	269.09	268.90	0.19	269.75	-0.66
St Dev	12.59	12.91	-0.32	12.80	-0.22
Min	233.00	223.00	10.00	223.00	10.00
Max	308.00	318.00	-10.00	318.00	-10.00
%					
1st	240.15	238.34	1.80	239.23	0.92
2nd	244.00	241.75	2.25	243.38	0.62
3rd	246.00	245.00	1.00	246.00	0.00
5th	248.90	248.00	0.90	249.00	-0.10
10th	253.00	252.09	0.91	253.00	0.00
15th	255.00	256.00	-1.00	256.24	-1.24
20th	258.00	258.00	0.00	259.00	-1.00
25th	260.00	260.00	0.00	261.00	-1.00
30th	262.00	262.00	0.00	263.00	-1.00
35th	264.00	264.00	0.00	264.40	-0.40
40th	266.00	265.00	1.00	266.00	0.00
45th	267.00	267.00	0.00	268.00	-1.00
50th	269.00	268.62	0.38	269.04	-0.04
55th	270.00	270.00	0.00	271.00	-1.00
60th	272.00	272.00	0.00	273.00	-1.00
65th	274.00	273.90	0.10	274.39	-0.39
70th	275.37	275.32	0.05	276.00	-0.63
75th	278.00	277.00	1.00	278.00	0.00
80th	280.00	280.00	0.00	280.00	0.00
85th	283.00	282.00	1.00	283.00	0.00
90th	285.00	286.00	-1.00	287.00	-2.00
95th	290.00	291.00	-1.00	291.97	-1.97
97th	292.00	295.00	-3.00	296.00	-4.00
98th	293.00	297.07	-4.07	297.20	-4.20
99th	299.46	300.46	-0.99	300.27	-0.81

Sitting Height

	USMC Males	Race/Age Match	USMC-Race/ Age Match	Race/Age/Wt Match	USMC-Race/ Age/Wt Match
	n=493	n=5103		n=4447	
Mean	924.64	915.71	8.93	917.44	7.20
St Dev	33.07	34.97	-1.90	34.84	-1.77
Min	825.00	779.00	46.00	779.00	46.00
Max	1005.00	1041.00	-36.00	1041.00	-36.00
%					
1st	845.64	832.18	13.46	834.06	11.58
2nd	854.00	843.26	10.74	845.20	8.80
3rd	858.19	850.41	7.78	852.01	6.18
5th	869.02	859.00	10.02	860.21	8.81
10th	883.00	871.06	11.94	872.56	10.44
15th	889.25	879.00	10.25	881.00	8.25
20th	897.77	885.49	12.28	887.82	9.95
25th	901.00	891.66	9.34	893.27	7.73
30th	908.71	897.85	10.86	899.23	9.48
35th	912.00	902.00	10.00	904.00	8.00
40th	917.00	907.00	10.00	908.00	9.00
45th	920.07	911.00	9.07	913.00	7.07
50th	925.00	915.67	9.33	918.00	7.00
55th	929.00	920.00	9.00	922.00	7.00
60th	932.00	925.00	7.00	926.00	6.00
65th	938.73	929.27	9.46	932.00	6.73
70th	944.00	934.89	9.11	936.65	7.35
75th	949.92	940.81	9.11	942.00	7.92
80th	954.00	945.28	8.72	947.00	7.00
85th	959.48	952.89	6.59	954.00	5.48
90th	968.43	961.00	7.43	962.74	5.69
95th	978.68	973.06	5.62	974.04	4.63
97th	986.00	980.47	5.53	981.28	4.72
98th	989.32	986.18	3.14	986.94	2.37
99th	998.74	997.11	1.63	997.37	1.38

Head Circumference

	USMC Males	Race/Age Match	USMC-Race/Age Match	Race/Age/Wt Match	USMC-Race/Age/Wt Match
	n=493	n=5103		n=4447	
Mean	568.80	567.23	1.58	568.18	0.63
St Dev	14.91	15.28	-0.37	15.23	-0.31
Min	529.00	514.00	15.00	514.00	15.00
Max	624.00	633.00	-9.00	633.00	-9.00
%					
1st	532.86	533.01	-0.15	533.40	-0.54
2nd	537.45	536.64	0.81	537.52	-0.08
3rd	543.03	539.00	4.03	540.24	2.80
5th	545.00	542.57	2.43	543.00	2.00
10th	550.00	548.00	2.00	549.00	1.00
15th	554.00	552.00	2.00	553.00	1.00
20th	557.00	554.00	3.00	555.71	1.29
25th	558.00	557.00	1.00	558.00	0.00
30th	560.86	559.00	1.86	560.00	0.86
35th	564.00	561.00	3.00	562.00	2.00
40th	565.00	563.00	2.00	564.00	1.00
45th	567.00	565.00	2.00	566.00	1.00
50th	568.00	567.00	1.00	568.00	0.00
55th	570.00	569.00	1.00	570.00	0.00
60th	572.00	571.00	1.00	572.00	0.00
65th	574.00	573.00	1.00	574.00	0.00
70th	576.00	575.00	1.00	576.00	0.00
75th	578.00	577.00	1.00	578.00	0.00
80th	581.00	580.00	1.00	581.00	0.00
85th	584.00	583.00	1.00	583.00	1.00
90th	588.00	586.86	1.14	587.14	0.86
95th	595.00	592.62	2.38	593.81	1.19
97th	598.00	597.00	1.00	598.64	-0.64
98th	601.06	601.55	-0.50	602.00	-0.94
99th	607.02	606.29	0.73	606.47	0.55

Menton-Sellion Length

	USMC Males	Race/Age Match	USMC-Race/ Age Match	Race/Age/Wt Match	USMC-Race/ Age/Wt Match
	n=493	n=5103		n=4447	
Mean	122.09	121.73	0.37	121.95	0.14
St Dev	6.71	6.44	0.27	6.51	0.21
Min	105.00	100.00	5.00	100.00	5.00
Max	143.00	149.00	-6.00	149.00	-6.00
%					
1st	107.00	107.00	0.00	107.00	0.00
2nd	108.00	109.00	-1.00	109.00	-1.00
3rd	109.00	110.00	-1.00	110.00	-1.00
5th	112.00	111.00	1.00	111.82	0.18
10th	114.00	114.00	0.00	114.00	0.00
15th	115.00	115.00	0.00	115.00	0.00
20th	116.00	116.00	0.00	116.00	0.00
25th	117.00	117.00	0.00	117.00	0.00
30th	118.00	118.00	0.00	118.00	0.00
35th	120.00	119.00	1.00	119.00	1.00
40th	120.00	120.00	0.00	120.00	0.00
45th	121.00	121.00	0.00	121.00	0.00
50th	122.00	122.00	0.00	122.00	0.00
55th	123.00	122.00	1.00	122.42	0.58
60th	123.00	123.00	0.00	123.00	0.00
65th	124.00	124.00	0.00	124.00	0.00
70th	126.00	125.00	1.00	125.00	1.00
75th	126.00	126.00	0.00	126.00	0.00
80th	127.00	127.00	0.00	127.00	0.00
85th	129.00	128.00	1.00	129.00	0.00
90th	131.00	130.00	1.00	130.00	1.00
95th	134.00	132.97	1.03	133.00	1.00
97th	136.00	134.00	2.00	134.99	1.01
98th	137.00	136.00	1.00	136.99	0.01
99th	140.00	138.37	1.63	139.00	1.00

APPENDIX C
Female Matching Results: Summary Statistics

APPENDIX C
Female Matching Results: Summary Statistics

Stature

	USMC Females	Race/Age Match	USMC-R/A Match	Race/Age/Wt Match	USMC-R/A/W Match
	n=470	n=3375		n=3201	
Mean	1630.83	1626.09	4.74	1629.54	1.29
St Dev	60.70	63.52	-2.83	63.57	-2.88
Min	1462.00	1460.00	2.00	1460.00	2.00
Max	1833.00	1836.00	-3.00	1836.00	-3.00
%					
1st	1491.98	1485.16	6.82	1486.05	5.94
2nd	1508.89	1499.28	9.62	1501.20	7.69
3rd	1518.00	1508.03	9.97	1513.09	4.91
5th	1527.36	1523.79	3.57	1527.15	0.21
10th	1553.00	1546.00	7.00	1549.93	3.07
15th	1567.00	1560.73	6.27	1564.00	3.00
20th	1579.63	1572.00	7.63	1576.00	3.63
25th	1592.46	1581.09	11.38	1585.00	7.46
30th	1600.00	1590.00	10.00	1593.00	7.00
35th	1607.71	1598.88	8.83	1602.00	5.71
40th	1616.57	1607.00	9.57	1609.59	6.98
45th	1625.00	1615.00	10.00	1619.15	5.85
50th	1631.00	1624.00	7.00	1628.00	3.00
55th	1639.06	1633.00	6.06	1636.54	2.51
60th	1647.50	1641.75	5.76	1645.31	2.19
65th	1653.24	1650.20	3.04	1654.00	-0.76
70th	1660.00	1659.05	0.95	1663.00	-3.00
75th	1669.00	1669.09	-0.09	1672.00	-3.00
80th	1679.60	1680.00	-0.40	1682.32	-2.72
85th	1691.00	1692.00	-1.00	1697.14	-6.14
90th	1710.00	1711.11	-1.11	1714.10	-4.10
95th	1733.70	1736.14	-2.44	1738.00	-4.30
97th	1743.60	1751.26	-7.66	1752.24	-8.64
98th	1770.97	1763.32	7.64	1767.12	3.85
99th	1786.23	1783.06	3.17	1784.09	2.14

Stature (cont.)

	USMC Females	Race/Age/Ht Match	USMC-R/A/H Match	Race/Age/Ht/Wt Match	USMC-R/A/H/W Match
	n=470	n=3192		n=2888	
Mean	1630.83	1631.75	-0.92	1631.52	-0.69
St Dev	60.70	61.80	-1.11	61.88	-1.18
Min	1462.00	1460.00	2.00	1460.00	2.00
Max	1833.00	1836.00	-3.00	1836.00	-3.00
%					
1st	1491.98	1488.03	3.96	1488.02	3.96
2nd	1508.89	1502.37	6.52	1502.39	6.51
3rd	1518.00	1515.39	2.61	1515.24	2.76
5th	1527.36	1531.21	-3.84	1529.31	-1.95
10th	1553.00	1552.40	0.61	1552.16	0.84
15th	1567.00	1567.96	-0.96	1567.90	-0.90
20th	1579.63	1579.56	0.07	1578.63	1.00
25th	1592.46	1590.00	2.46	1589.94	2.52
30th	1600.00	1600.00	0.00	1599.26	0.74
35th	1607.71	1608.46	-0.75	1608.00	-0.29
40th	1616.57	1615.81	0.76	1616.00	0.57
45th	1625.00	1623.00	2.00	1624.11	0.89
50th	1631.00	1631.54	-0.54	1631.72	-0.72
55th	1639.06	1639.26	-0.20	1639.49	-0.44
60th	1647.50	1646.00	1.50	1646.00	1.50
65th	1653.24	1654.00	-0.76	1653.00	0.24
70th	1660.00	1662.84	-2.84	1661.10	-1.10
75th	1669.00	1672.00	-3.00	1671.00	-2.00
80th	1679.60	1682.06	-2.46	1682.00	-2.40
85th	1691.00	1695.75	-4.75	1696.01	-5.01
90th	1710.00	1713.00	-3.00	1713.12	-3.12
95th	1733.70	1737.56	-3.86	1738.00	-4.30
97th	1743.60	1751.78	-8.18	1752.00	-8.40
98th	1770.97	1764.34	6.63	1764.08	6.89
99th	1786.23	1784.10	2.13	1783.13	3.10

Weight

	USMC Females	Race/Age Match	USMC-R/A Match	Race/Age/Wt Match	USMC-R/A/W Match
	n=470	n=3375		n=3201	
Mean	619.50	614.36	5.14	620.63	-1.13
St Dev	79.22	80.84	-1.62	79.79	-0.56
Min	418.00	416.00	2.00	416.00	2.00
Max	883.00	995.00	-112.00	995.00	-112.00
%					
1st	447.74	457.04	-9.30	457.33	-9.58
2nd	465.80	470.06	-4.26	471.20	-5.40
3rd	473.24	478.60	-5.37	481.19	-7.95
5th	500.64	496.02	4.62	499.41	1.23
10th	518.00	516.75	1.25	520.00	-2.00
15th	537.00	531.00	6.00	536.24	0.76
20th	552.15	545.00	7.15	551.04	1.11
25th	564.00	556.52	7.48	564.08	-0.08
30th	576.00	568.00	8.00	576.08	-0.08
35th	585.78	579.61	6.17	588.03	-2.25
40th	596.69	590.00	6.69	598.33	-1.63
45th	604.77	600.00	4.77	607.93	-3.16
50th	614.00	608.02	5.98	615.82	-1.82
55th	625.00	617.00	8.00	625.00	0.00
60th	638.00	626.00	12.00	635.00	3.00
65th	646.57	635.87	10.69	647.00	-0.43
70th	661.00	648.00	13.00	657.62	3.38
75th	670.15	660.62	9.53	670.00	0.15
80th	681.94	677.15	4.80	686.00	-4.06
85th	699.11	698.33	0.78	702.02	-2.91
90th	724.41	720.25	4.15	721.41	2.99
95th	752.51	763.03	-10.52	762.57	-10.06
97th	790.45	793.18	-2.74	793.06	-2.62
98th	798.15	813.03	-14.88	811.17	-13.03
99th	838.79	845.18	-6.39	839.16	-0.37

Weight (cont.)

	USMC Females	Race/Age/Ht Match	USMC-R/A/H Match	Race/Age/Ht/Wt Match	USMC-R/A/H/W Match
	n=470	n=3192		n=2888	
Mean	619.50	617.95	1.55	621.82	-2.32
St Dev	79.22	81.37	-2.15	81.61	-2.39
Min	418.00	416.00	2.00	416.00	2.00
Max	883.00	995.00	-112.00	995.00	-112.00
%					
1st	447.74	459.21	-11.47	459.20	-11.46
2nd	465.80	474.05	-8.25	473.22	-7.42
3rd	473.24	484.19	-10.95	484.11	-10.88
5th	500.64	501.01	-0.37	502.06	-1.42
10th	518.00	520.00	-2.00	521.24	-3.24
15th	537.00	534.16	2.84	536.00	1.00
20th	552.15	547.35	4.80	550.48	1.66
25th	564.00	559.35	4.65	564.23	-0.23
30th	576.00	571.15	4.85	575.88	0.12
35th	585.78	583.00	2.78	587.00	-1.22
40th	596.69	593.98	2.71	598.03	-1.34
45th	604.77	603.00	1.77	607.74	-2.97
50th	614.00	610.70	3.30	615.33	-1.33
55th	625.00	620.00	5.00	625.55	-0.55
60th	638.00	630.48	7.52	635.79	2.21
65th	646.57	639.88	6.69	648.66	-2.10
70th	661.00	652.17	8.83	659.35	1.65
75th	670.15	665.16	4.99	671.00	-0.85
80th	681.94	682.66	-0.71	688.58	-6.63
85th	699.11	701.25	-2.14	704.21	-5.10
90th	724.41	724.04	0.37	723.27	1.14
95th	752.51	767.49	-14.98	766.14	-13.63
97th	790.45	800.09	-9.64	800.15	-9.70
98th	798.15	820.02	-21.87	821.03	-22.88
99th	838.79	846.52	-7.74	855.20	-16.41

Waist Height

	USMC Females	Race/Age Match	USMC-R/A Match	Race/Age/Wt Match	USMC-R/A/W Match
	n=470	n=3375		n=3201	
Mean	984.08	977.63	6.45	980.19	3.89
St Dev	46.65	48.40	-1.75	48.81	-2.17
Min	846.00	817.00	29.00	817.00	29.00
Max	1144.00	1190.00	-46.00	1190.00	-46.00
%					
1st	880.44	872.25	8.19	872.38	8.05
2nd	890.79	881.00	9.79	881.35	9.43
3rd	897.00	887.08	9.92	888.13	8.87
5th	908.25	900.72	7.53	902.21	6.04
10th	926.09	917.00	9.09	919.38	6.71
15th	937.00	928.00	9.00	930.03	6.98
20th	946.00	936.00	10.00	938.00	8.00
25th	952.34	943.73	8.60	945.03	7.31
30th	957.63	951.00	6.63	953.00	4.63
35th	964.00	956.52	7.48	960.00	4.00
40th	970.21	964.00	6.21	966.03	4.18
45th	977.00	970.79	6.21	973.00	4.00
50th	984.00	976.00	8.00	978.15	5.85
55th	990.00	982.00	8.00	984.00	6.00
60th	996.82	987.80	9.02	991.00	5.82
65th	1002.00	995.00	7.00	998.00	4.00
70th	1009.00	1003.00	6.00	1006.00	3.00
75th	1013.89	1011.40	2.49	1014.18	-0.29
80th	1021.25	1020.00	1.25	1022.23	-0.98
85th	1031.52	1028.00	3.52	1032.00	-0.48
90th	1041.00	1040.00	1.00	1043.99	-2.98
95th	1063.20	1060.21	2.99	1064.54	-1.34
97th	1077.33	1074.12	3.21	1076.23	1.10
98th	1090.23	1082.22	8.01	1083.13	7.11
99th	1103.32	1096.01	7.31	1096.23	7.09

Waist Height (cont.)

	USMC Females	Race/Age/Ht Match	USMC-R/A/H Match	Race/Age/Ht/Wt Match	USMC-R/A/H/W Match
	n=470	n=3192		n=2888	
Mean	984.08	981.55	2.53	981.66	2.42
St Dev	46.65	47.49	-0.84	47.42	-0.77
Min	846.00	817.00	29.00	839.00	7.00
Max	1144.00	1190.00	-46.00	1190.00	-46.00
%					
1st	880.44	874.19	6.25	874.25	6.19
2nd	890.79	883.44	7.35	883.53	7.26
3rd	897.00	893.29	3.71	893.25	3.75
5th	908.25	904.76	3.49	904.98	3.27
10th	926.09	921.73	4.36	921.71	4.38
15th	937.00	933.35	3.65	933.00	4.00
20th	946.00	941.00	5.00	941.00	5.00
25th	952.34	949.62	2.71	950.00	2.34
30th	957.63	956.00	1.63	956.00	1.63
35th	964.00	962.65	1.35	963.67	0.33
40th	970.21	969.97	0.23	970.11	0.10
45th	977.00	975.00	2.00	975.99	1.01
50th	984.00	980.00	4.00	980.00	4.00
55th	990.00	985.00	5.00	985.00	5.00
60th	996.82	991.67	5.15	991.00	5.82
65th	1002.00	998.56	3.44	998.00	4.00
70th	1009.00	1006.00	3.00	1005.00	4.00
75th	1013.89	1014.05	-0.16	1013.40	0.49
80th	1021.25	1022.00	-0.75	1022.00	-0.75
85th	1031.52	1030.36	1.15	1031.18	0.34
90th	1041.00	1042.36	-1.36	1044.00	-3.00
95th	1063.20	1063.07	0.13	1064.24	-1.04
97th	1077.33	1076.16	1.16	1075.49	1.84
98th	1090.23	1084.06	6.18	1082.33	7.90
99th	1103.32	1096.24	7.08	1096.19	7.14

Sleeve Outseam Length

	USMC Females	Race/Age Match	USMC-R/A Match	Race/Age/Wt Match	USMC-R/A/W Match
	n=470	n=3375		n=3201	
Mean	548.40	543.12	5.28	544.64	3.76
St Dev	29.89	29.29	0.60	29.33	0.56
Min	480.00	454.00	26.00	454.00	26.00
Max	641.00	678.00	-37.00	678.00	-37.00
%					
1st	484.48	478.17	6.31	479.26	5.22
2nd	493.32	485.78	7.54	487.01	6.31
3rd	496.38	490.93	5.45	491.27	5.11
5th	502.00	496.75	5.25	498.45	3.55
10th	513.32	506.00	7.32	507.18	6.14
15th	519.00	512.00	7.00	514.73	4.27
20th	523.54	517.00	6.54	519.80	3.75
25th	525.00	523.00	2.00	524.51	0.49
30th	530.63	527.00	3.63	528.62	2.01
35th	534.17	531.00	3.17	532.00	2.17
40th	538.00	535.00	3.00	536.00	2.00
45th	542.00	538.02	3.99	540.00	2.00
50th	546.00	542.00	4.00	543.93	2.07
55th	550.00	545.98	4.02	547.50	2.50
60th	555.00	550.00	5.00	552.00	3.00
65th	559.00	554.42	4.58	555.00	4.00
70th	562.00	558.28	3.72	560.00	2.00
75th	567.00	563.00	4.00	564.00	3.00
80th	574.96	567.61	7.34	570.00	4.96
85th	579.32	574.00	5.32	576.00	3.32
90th	587.37	581.00	6.37	583.25	4.11
95th	596.40	593.00	3.40	594.71	1.69
97th	610.00	600.03	9.97	601.25	8.76
98th	620.61	604.54	16.06	605.36	15.25
99th	634.59	617.04	17.55	617.10	17.50

Sleeve Outseam Length (cont.)

	USMC Females	Race/Age/Ht Match	USMC-R/A/H Match	Race/Age/Ht/Wt Match	USMC-R/A/H/W Match
	n=470	n=3192		n=2888	
Mean	548.40	545.13	3.27	545.33	3.08
St Dev	29.89	29.22	0.67	29.23	0.66
Min	480.00	454.00	26.00	454.00	26.00
Max	641.00	678.00	-37.00	678.00	-37.00
%					
1st	484.48	480.03	4.45	480.10	4.38
2nd	493.32	487.46	5.86	488.25	5.07
3rd	496.38	491.94	4.44	492.00	4.38
5th	502.00	499.81	2.19	499.93	2.07
10th	513.32	508.00	5.32	508.00	5.32
15th	519.00	515.00	4.00	515.00	4.00
20th	523.54	520.00	3.54	520.00	3.54
25th	525.00	525.00	0.00	525.00	0.00
30th	530.63	529.60	1.04	530.00	0.63
35th	534.17	533.24	0.93	533.44	0.73
40th	538.00	537.00	1.00	537.00	1.00
45th	542.00	540.65	1.35	541.00	1.00
50th	546.00	544.00	2.00	544.00	2.00
55th	550.00	548.00	2.00	548.00	2.00
60th	555.00	552.00	3.00	552.00	3.00
65th	559.00	556.00	3.00	556.00	3.00
70th	562.00	560.00	2.00	560.00	2.00
75th	567.00	564.43	2.57	564.00	3.00
80th	574.96	570.00	4.96	570.00	4.96
85th	579.32	575.97	3.34	576.00	3.32
90th	587.37	583.00	4.37	584.17	3.19
95th	596.40	594.80	1.60	595.79	0.62
97th	610.00	602.06	7.94	602.62	7.38
98th	620.61	607.00	13.60	606.36	14.24
99th	634.59	621.10	13.50	620.20	14.39

Chest Circumference

	USMC Females	Race/Age Match	USMC-R/A Match	Race/Age/Wt Match	USMC-R/A/W Match
	n=470	n=3375		n=3201	
Mean	925.70	907.93	17.77	911.16	14.54
St Dev	59.94	62.24	-2.30	61.49	-1.55
Min	745.00	711.00	34.00	711.00	34.00
Max	1144.00	1222.00	-78.00	1222.00	-78.00
1st	795.75	786.18	9.58	786.36	9.40
%					
2nd	806.31	797.02	9.29	798.21	8.10
3rd	825.00	803.23	21.77	805.29	19.71
5th	839.00	815.20	23.80	817.48	21.52
10th	857.84	832.75	25.09	835.18	22.66
15th	868.00	844.09	23.91	847.32	20.68
20th	874.00	854.00	20.00	859.00	15.00
25th	880.00	865.00	15.00	869.00	11.00
30th	889.00	873.18	15.83	877.00	12.00
35th	899.00	881.00	18.00	884.00	15.00
40th	906.00	888.00	18.00	893.00	13.00
45th	914.00	895.00	19.00	899.30	14.70
50th	922.50	902.13	20.37	906.00	16.50
55th	929.00	910.00	19.00	914.00	15.00
60th	940.00	918.00	22.00	922.00	18.00
65th	946.17	925.67	20.49	930.30	15.87
70th	953.00	935.00	18.00	938.77	14.23
75th	961.87	945.51	16.36	949.00	12.87
80th	973.15	958.00	15.15	961.73	11.42
85th	988.62	970.14	18.49	973.32	15.30
90th	1001.28	992.18	9.09	993.27	8.01
95th	1032.28	1022.24	10.04	1021.34	10.94
97th	1053.47	1043.11	10.36	1041.06	12.41
98th	1056.03	1059.05	-3.02	1057.27	-1.24
99th	1095.56	1081.43	14.12	1081.24	14.32

Chest Circumference (cont.)

	USMC Females	Race/Age/Ht Match	USMC-R/A/H Match	Race/Age/Ht/Wt Match	USMC-R/A/H/W Match
	n=470	n=3192		n=2888	
Mean	925.70	909.04	16.66	911.33	14.37
St Dev	59.94	62.51	-2.57	62.66	-2.72
Min	745.00	711.00	34.00	711.00	34.00
Max	1144.00	1222.00	-78.00	1222.00	-78.00
%					
1st	795.75	786.22	9.53	786.30	9.45
2nd	806.31	798.06	8.25	797.18	9.14
3rd	825.00	805.05	19.95	805.20	19.80
5th	839.00	816.51	22.49	817.51	21.49
10th	857.84	833.97	23.88	835.25	22.59
15th	868.00	845.00	23.00	847.63	20.37
20th	874.00	855.00	19.00	858.54	15.46
25th	880.00	866.00	14.00	868.97	11.03
30th	889.00	874.00	15.00	877.00	12.00
35th	899.00	882.00	17.00	884.00	15.00
40th	906.00	888.59	17.41	891.36	14.64
45th	914.00	895.00	19.00	899.00	15.00
50th	922.50	903.00	19.50	905.00	17.50
55th	929.00	910.42	18.58	914.00	15.00
60th	940.00	918.40	21.60	921.56	18.44
65th	946.17	926.00	20.17	928.42	17.75
70th	953.00	936.00	17.00	937.00	16.00
75th	961.87	947.00	14.87	948.00	13.87
80th	973.15	959.17	13.98	962.00	11.15
85th	988.62	971.49	17.13	974.68	13.95
90th	1001.28	994.35	6.93	996.11	5.16
95th	1032.28	1025.31	6.97	1028.61	3.67
97th	1053.47	1044.79	8.68	1046.00	7.47
98th	1056.03	1059.50	-3.47	1063.22	-7.19
99th	1095.56	1083.18	12.38	1096.25	-0.69

Waist Circumference

	USMC Females	Race/Age Match	USMC-R/A Match	Race/Age/Wt Match	USMC-R/A/W Match
	n=470	n=3375		n=3201	
Mean	775.38	792.31	-16.93	796.42	-21.03
St Dev	69.35	80.24	-10.89	78.68	-9.33
Min	625.00	608.00	17.00	610.00	15.00
Max	1034.00	1108.00	-74.00	1108.00	-74.00
%					
1st	640.64	652.13	-11.49	653.56	-12.92
2nd	653.00	662.31	-9.31	664.14	-11.14
3rd	658.04	668.00	-9.96	669.54	-11.50
5th	665.90	679.14	-13.24	682.31	-16.41
10th	687.29	699.02	-11.73	702.49	-15.20
15th	701.77	712.53	-10.75	716.76	-14.98
20th	710.19	724.00	-13.81	727.79	-17.60
25th	721.47	733.07	-11.61	738.00	-16.53
30th	732.00	743.00	-11.00	747.96	-15.96
35th	741.00	752.17	-11.17	758.77	-17.77
40th	749.00	763.05	-14.05	770.00	-21.00
45th	761.36	772.33	-10.97	778.96	-17.60
50th	772.00	782.00	-10.00	788.00	-16.00
55th	782.00	791.98	-9.98	798.25	-16.25
60th	792.00	803.00	-11.00	808.44	-16.44
65th	805.00	814.48	-9.48	818.85	-13.85
70th	816.12	825.00	-8.88	831.41	-15.29
75th	825.00	838.00	-13.00	844.18	-19.18
80th	835.45	854.96	-19.51	858.00	-22.55
85th	852.82	874.86	-22.05	877.66	-24.85
90th	866.00	907.26	-41.26	908.13	-42.13
95th	891.36	944.07	-52.71	940.17	-48.81
97th	909.58	974.22	-64.64	970.19	-60.61
98th	924.06	1001.11	-77.05	1000.03	-75.97
99th	950.00	1027.09	-77.09	1021.05	-71.05

Waist Circumference (cont.)

	USMC Females	Race/Age/Ht Match	USMC-R/A/H Match	Race/Age/Ht/Wt Match	USMC-R/A/H/W Match
	n=470	n=3192		n=2888	
Mean	775.38	793.40	-18.02	795.62	-20.24
St Dev	69.35	80.18	-10.83	79.28	-9.93
Min	625.00	610.00	15.00	610.00	15.00
Max	1034.00	1108.00	-74.00	1108.00	-74.00
%					
1st	640.64	653.65	-13.01	653.38	-12.74
2nd	653.00	664.01	-11.01	664.37	-11.37
3rd	658.04	669.63	-11.59	670.40	-12.36
5th	665.90	680.82	-14.91	683.25	-17.35
10th	687.29	700.26	-12.97	701.81	-14.52
15th	701.77	713.00	-11.23	715.77	-13.99
20th	710.19	725.00	-14.81	726.11	-15.91
25th	721.47	734.00	-12.53	738.00	-16.53
30th	732.00	743.49	-11.49	748.02	-16.02
35th	741.00	753.64	-12.64	758.47	-17.47
40th	749.00	765.00	-16.00	769.53	-20.53
45th	761.36	773.81	-12.45	777.00	-15.64
50th	772.00	782.42	-10.42	785.00	-13.00
55th	782.00	792.00	-10.00	795.60	-13.60
60th	792.00	803.00	-11.00	806.00	-14.00
65th	805.00	815.00	-10.00	817.00	-12.00
70th	816.12	826.00	-9.88	829.06	-12.94
75th	825.00	838.89	-13.89	840.25	-15.25
80th	835.45	855.53	-20.08	856.48	-21.03
85th	852.82	875.17	-22.35	875.00	-22.18
90th	866.00	909.50	-43.50	910.02	-44.02
95th	891.36	946.10	-54.74	941.00	-49.64
97th	909.58	977.21	-67.63	974.39	-64.81
98th	924.06	1001.09	-77.04	1004.03	-79.97
99th	950.00	1026.05	-76.05	1042.12	-92.12

Buttock Circumference

	USMC Females	Race/Age Match	USMC-R/A Match	Race/Age/Wt Match	USMC-R/A/W Match
	n=470	n=3375		n=3201	
Mean	972.98	964.67	8.31	969.05	3.93
St Dev	58.53	58.68	-0.15	57.70	0.83
Min	813.00	787.00	26.00	787.00	26.00
Max	1157.00	1189.00	-32.00	1189.00	-32.00
%					
1st	840.88	843.73	-2.85	846.07	-5.18
2nd	860.70	858.40	2.30	861.40	-0.70
3rd	866.82	865.32	1.50	868.09	-1.28
5th	875.00	874.68	0.32	877.72	-2.72
10th	900.00	890.58	9.42	894.19	5.82
15th	910.97	902.13	8.85	907.32	3.65
20th	919.99	913.00	6.99	918.75	1.24
25th	928.10	923.00	5.10	928.00	0.10
30th	938.40	931.69	6.71	937.83	0.57
35th	952.00	939.30	12.70	945.11	6.89
40th	960.00	947.41	12.60	952.86	7.14
45th	967.00	953.84	13.16	960.00	7.00
50th	973.00	960.37	12.63	967.61	5.39
55th	981.26	969.00	12.26	975.00	6.26
60th	987.72	976.77	10.95	982.03	5.69
65th	996.00	984.57	11.43	990.09	5.91
70th	1002.00	994.00	8.00	998.89	3.11
75th	1012.00	1003.97	8.03	1008.23	3.77
80th	1021.39	1014.00	7.39	1018.00	3.39
85th	1030.71	1025.64	5.07	1028.39	2.32
90th	1045.00	1041.00	4.00	1043.23	1.77
95th	1070.33	1066.79	3.54	1068.13	2.20
97th	1095.72	1083.27	12.45	1081.53	14.18
98th	1102.70	1101.52	1.18	1096.46	6.24
99th	1129.19	1127.46	1.73	1125.23	3.96

Buttock Circumference (cont.)

	USMC Females	Race/Age/Ht Match	USMC-R/A/H Match	Race/Age/Ht/Wt Match	USMC-R/A/H/W Match
	n=470	n=3192		n=2888	
Mean	972.98	966.56	6.43	969.01	3.97
St Dev	58.53	58.97	-0.44	58.44	0.09
Min	813.00	787.00	26.00	787.00	26.00
Max	1157.00	1189.00	-32.00	1189.00	-32.00
%					
1st	840.88	847.16	-6.27	847.21	-6.33
2nd	860.70	861.62	-0.92	862.14	-1.44
3rd	866.82	867.05	-0.23	869.08	-2.26
5th	875.00	876.56	-1.56	878.00	-3.00
10th	900.00	892.28	7.72	894.00	6.00
15th	910.97	903.00	7.97	904.71	6.26
20th	919.99	914.12	5.87	917.80	2.19
25th	928.10	924.53	3.57	928.00	0.10
30th	938.40	933.00	5.40	937.83	0.57
35th	952.00	941.89	10.11	944.57	7.43
40th	960.00	949.00	11.00	952.00	8.00
45th	967.00	955.44	11.56	959.30	7.71
50th	973.00	963.00	10.00	967.31	5.69
55th	981.26	970.30	10.96	975.00	6.26
60th	987.72	978.75	8.97	982.00	5.72
65th	996.00	986.70	9.30	990.00	6.00
70th	1002.00	996.18	5.83	998.00	4.00
75th	1012.00	1005.59	6.41	1008.00	4.00
80th	1021.39	1016.47	4.92	1017.95	3.44
85th	1030.71	1027.90	2.81	1028.00	2.71
90th	1045.00	1043.54	1.46	1043.64	1.36
95th	1070.33	1069.15	1.18	1069.36	0.97
97th	1095.72	1086.31	9.41	1084.31	11.41
98th	1102.70	1104.05	-1.35	1105.04	-2.34
99th	1129.19	1130.19	-1.00	1130.16	-0.96

Foot Breadth

	USMC Females	Race/Age Match	USMC-R/A Match	Race/Age/Wt Match	USMC-R/A/W Match
	n=470	n=3375		n=3201	
Mean	90.79	89.22	1.57	89.47	1.31
St Dev	4.92	4.77	0.15	4.77	0.15
Min	77.00	74.00	3.00	74.00	3.00
Max	109.00	109.00	0.00	109.00	0.00
%					
1st	80.44	78.72	1.72	79.00	1.44
2nd	82.00	80.00	2.00	80.00	2.00
3rd	82.21	80.18	2.02	81.00	1.21
5th	83.00	82.00	1.00	82.00	1.00
10th	84.00	83.00	1.00	84.00	0.00
15th	85.00	84.00	1.00	85.00	0.00
20th	86.00	85.00	1.00	85.00	1.00
25th	87.00	86.00	1.00	86.00	1.00
30th	88.00	87.00	1.00	87.00	1.00
35th	89.00	87.00	2.00	88.00	1.00
40th	90.00	88.00	2.00	88.00	2.00
45th	90.00	88.04	1.96	89.00	1.00
50th	91.00	89.00	2.00	89.00	2.00
55th	91.00	90.00	1.00	90.00	1.00
60th	92.00	90.00	2.00	90.00	2.00
65th	92.00	91.00	1.00	91.00	1.00
70th	93.00	92.00	1.00	92.00	1.00
75th	94.00	92.00	2.00	93.00	1.00
80th	94.68	93.00	1.68	93.40	1.28
85th	96.00	94.00	2.00	95.00	1.00
90th	97.00	95.00	2.00	95.25	1.75
95th	100.00	97.48	2.52	98.00	2.00
97th	100.78	98.00	2.78	98.00	2.78
98th	102.00	99.89	2.11	100.00	2.00
99th	104.00	101.23	2.77	101.37	2.63

Foot Breadth (cont.)

	USMC Females	Race/Age/Ht Match	USMC-R/A/H Match	Race/Age/Ht/Wt Match	USMC-R/A/H/W Match
	n=470	n=3192		n=2888	
Mean	90.79	89.40	1.38	89.52	1.27
St Dev	4.92	4.80	0.12	4.82	0.11
Min	77.00	74.00	3.00	74.00	3.00
Max	109.00	109.00	0.00	107.00	2.00
%					
1st	80.44	78.88	1.56	78.76	1.68
2nd	82.00	80.00	2.00	80.00	2.00
3rd	82.21	81.00	1.21	81.00	1.21
5th	83.00	82.00	1.00	82.00	1.00
10th	84.00	84.00	0.00	84.00	0.00
15th	85.00	84.79	0.21	84.97	0.03
20th	86.00	85.00	1.00	85.00	1.00
25th	87.00	86.00	1.00	86.00	1.00
30th	88.00	87.00	1.00	87.00	1.00
35th	89.00	87.00	2.00	88.00	1.00
40th	90.00	88.00	2.00	88.00	2.00
45th	90.00	89.00	1.00	89.00	1.00
50th	91.00	89.00	2.00	89.00	2.00
55th	91.00	90.00	1.00	90.00	1.00
60th	92.00	90.00	2.00	90.00	2.00
65th	92.00	91.00	1.00	91.00	1.00
70th	93.00	92.00	1.00	92.00	1.00
75th	94.00	93.00	1.00	93.00	1.00
80th	94.68	93.00	1.68	94.00	0.68
85th	96.00	95.00	1.00	95.00	1.00
90th	97.00	95.00	2.00	95.02	1.98
95th	100.00	98.00	2.00	98.00	2.00
97th	100.78	98.51	2.27	98.24	2.54
98th	102.00	100.00	2.00	100.00	2.00
99th	104.00	102.17	1.83	102.37	1.63

Foot Length

	USMC Females	Race/Age Match	USMC-R/A Match	Race/Age/Wt Match	USMC-R/A/W Match
	n=470	n=3375		n=3201	
Mean	242.75	242.71	0.04	243.37	-0.62
St Dev	12.00	11.91	0.09	11.93	0.07
Min	205.00	203.00	2.00	203.00	2.00
Max	287.00	290.00	-3.00	290.00	-3.00
%					
1st	212.00	215.56	-3.56	216.19	-4.19
2nd	217.14	218.78	-1.64	219.00	-1.86
3rd	221.76	220.57	1.19	221.00	0.76
5th	225.00	223.00	2.00	224.00	1.00
10th	229.00	227.29	1.71	228.00	1.00
15th	232.00	230.00	2.00	231.00	1.00
20th	233.00	233.00	0.00	233.00	0.00
25th	235.00	235.00	0.00	235.00	0.00
30th	236.00	236.00	0.00	237.00	-1.00
35th	237.00	238.00	-1.00	238.00	-1.00
40th	239.00	239.00	0.00	240.00	-1.00
45th	240.00	241.00	-1.00	242.00	-2.00
50th	242.00	242.34	-0.34	243.00	-1.00
55th	244.00	244.00	0.00	245.00	-1.00
60th	245.00	245.60	-0.60	246.00	-1.00
65th	247.00	247.00	0.00	248.00	-1.00
70th	249.00	248.00	1.00	250.00	-1.00
75th	250.50	251.00	-0.50	251.87	-1.37
80th	253.00	253.00	0.00	254.00	-1.00
85th	255.00	255.00	0.00	256.00	-1.00
90th	257.00	258.00	-1.00	259.00	-2.00
95th	263.53	263.00	0.53	263.00	0.53
97th	267.46	266.00	1.46	266.00	1.46
98th	271.20	267.92	3.27	268.07	3.13
99th	274.00	271.12	2.88	271.30	2.70

Foot Length (cont.)

	USMC Females	Race/Age/Ht Match	USMC-R/A/H Match	Race/Age/Ht/Wt Match	USMC-R/A/H/W Match
	n=470	n=3192		n=2888	
Mean	242.75	243.46	-0.71	243.63	-0.88
St Dev	12.00	11.86	0.14	11.94	0.06
Min	205.00	203.00	2.00	203.00	2.00
Max	287.00	290.00	-3.00	290.00	-3.00
%					
1st	212.00	216.33	-4.33	216.11	-4.11
2nd	217.14	219.00	-1.86	219.00	-1.86
3rd	221.76	221.23	0.53	221.06	0.70
5th	225.00	224.00	1.00	224.00	1.00
10th	229.00	228.00	1.00	228.00	1.00
15th	232.00	231.00	1.00	231.00	1.00
20th	233.00	233.24	-0.24	233.00	0.00
25th	235.00	235.36	-0.36	235.20	-0.19
30th	236.00	237.00	-1.00	237.00	-1.00
35th	237.00	238.00	-1.00	238.00	-1.00
40th	239.00	240.00	-1.00	240.00	-1.00
45th	240.00	242.00	-2.00	242.00	-2.00
50th	242.00	243.00	-1.00	244.00	-2.00
55th	244.00	245.00	-1.00	245.00	-1.00
60th	245.00	246.00	-1.00	247.00	-2.00
65th	247.00	248.00	-1.00	248.00	-1.00
70th	249.00	249.97	-0.97	250.00	-1.00
75th	250.50	251.00	-0.50	252.00	-1.50
80th	253.00	254.00	-1.00	254.00	-1.00
85th	255.00	256.00	-1.00	256.00	-1.00
90th	257.00	259.00	-2.00	259.00	-2.00
95th	263.53	263.21	0.32	263.00	0.53
97th	267.46	266.00	1.46	266.00	1.46
98th	271.20	268.16	3.04	268.00	3.20
99th	274.00	271.41	2.59	271.18	2.82

Sitting Height

	USMC Females	Race/Age Match	USMC-R/A Match	Race/Age/Wt Match	USMC-R/A/W Match
	n=470	n=3375		n=3201	
Mean	866.80	854.76	12.04	856.26	10.54
St Dev	30.76	34.14	-3.37	33.96	-3.20
Min	787.00	735.00	52.00	748.00	39.00
Max	974.00	963.00	11.00	963.00	11.00
1st	793.27	778.38	14.89	780.25	13.02
%					
2nd	801.09	785.23	15.86	787.38	13.71
3rd	809.00	789.89	19.11	792.28	16.72
5th	814.39	798.21	16.19	799.76	14.63
10th	825.00	811.00	14.00	812.38	12.62
15th	836.87	819.50	17.38	821.00	15.87
20th	843.00	825.00	18.00	826.99	16.01
25th	847.00	831.00	16.00	833.00	14.00
30th	850.00	836.00	14.00	837.39	12.61
35th	853.89	840.00	13.89	842.00	11.89
40th	857.00	845.00	12.00	846.27	10.73
45th	862.00	850.00	12.00	852.00	10.00
50th	867.00	854.00	13.00	856.00	11.00
55th	870.00	859.32	10.68	861.00	9.00
60th	874.17	864.00	10.17	866.00	8.17
65th	879.00	869.00	10.00	870.10	8.90
70th	884.61	873.33	11.28	874.79	9.82
75th	890.00	878.00	12.00	879.00	11.00
80th	895.14	884.00	11.14	885.50	9.64
85th	900.00	890.00	10.00	891.00	9.00
90th	905.00	898.14	6.86	899.51	5.49
95th	915.00	912.46	2.54	912.94	2.06
97th	924.56	920.22	4.34	920.58	3.98
98th	928.00	925.43	2.57	927.02	0.98
99th	940.21	936.31	3.90	936.48	3.72

Sitting Height (cont.)

	USMC Females	Race/Age/Ht Match	USMC-R/A/H Match	Race/Age/Ht/Wt Match	USMC-R/A/H/W Match
	n=470	n=3192		n=2888	
Mean	866.80	857.21	9.59	857.22	9.58
St Dev	30.76	33.20	-2.44	33.27	-2.51
Min	787.00	748.00	39.00	748.00	39.00
Max	974.00	963.00	11.00	963.00	11.00
%					
1st	793.27	781.13	12.15	781.04	12.23
2nd	801.09	787.67	13.42	787.79	13.30
3rd	809.00	793.21	15.79	794.14	14.86
5th	814.39	801.44	12.95	800.76	13.63
10th	825.00	814.33	10.67	814.00	11.00
15th	836.87	823.00	13.87	823.00	13.87
20th	843.00	828.31	14.69	829.00	14.00
25th	847.00	834.88	12.12	835.00	12.00
30th	850.00	839.00	11.00	840.00	10.00
35th	853.89	844.00	9.89	844.00	9.89
40th	857.00	849.00	8.00	849.00	8.00
45th	862.00	853.00	9.00	853.00	9.00
50th	867.00	857.07	9.93	857.81	9.20
55th	870.00	862.00	8.00	862.62	7.38
60th	874.17	866.51	7.66	866.00	8.17
65th	879.00	871.00	8.00	870.11	8.89
70th	884.61	875.00	9.61	875.00	9.61
75th	890.00	880.00	10.00	880.00	10.00
80th	895.14	886.00	9.14	886.00	9.14
85th	900.00	891.00	9.00	890.56	9.44
90th	905.00	899.00	6.00	899.00	6.00
95th	915.00	912.68	2.32	912.18	2.82
97th	924.56	920.24	4.32	920.11	4.45
98th	928.00	925.50	2.50	926.07	1.93
99th	940.21	936.36	3.84	936.52	3.69

Head Circumference

	USMC Females	Race/Age Match	USMC-R/A Match	Race/Age/Wt Match	USMC-R/A/W Match
	n=470	n=3375		n=3201	
Mean	552.82	544.81	8.01	545.20	7.62
St Dev	15.03	14.47	0.56	14.45	0.58
Min	508.00	500.00	8.00	500.00	8.00
Max	613.00	615.00	-2.00	615.00	-2.00
%					
1st	517.97	511.36	6.61	512.30	5.67
2nd	523.00	516.00	7.00	516.54	6.46
3rd	523.91	518.60	5.31	519.00	4.91
5th	527.00	521.16	5.85	522.00	5.00
10th	535.00	527.00	8.00	527.00	8.00
15th	538.00	530.00	8.00	530.12	7.88
20th	541.09	533.00	8.09	533.00	8.09
25th	543.00	535.00	8.00	535.00	8.00
30th	545.00	537.00	8.00	538.00	7.00
35th	547.00	539.00	8.00	539.00	8.00
40th	549.00	541.00	8.00	541.00	8.00
45th	550.03	543.00	7.03	543.00	7.03
50th	552.00	544.00	8.00	545.00	7.00
55th	554.00	546.00	8.00	547.00	7.00
60th	555.40	548.00	7.40	549.00	6.40
65th	557.97	550.00	7.97	551.00	6.97
70th	560.89	552.00	8.89	553.00	7.89
75th	562.00	554.00	8.00	554.00	8.00
80th	564.00	557.00	7.00	557.00	7.00
85th	567.00	560.00	7.00	560.00	7.00
90th	571.85	563.00	8.85	564.00	7.85
95th	578.00	568.71	9.29	569.00	9.00
97th	583.00	572.12	10.88	572.41	10.59
98th	590.00	575.39	14.61	575.35	14.66
99th	594.00	584.06	9.94	584.26	9.74

Head Circumference (cont.)

	USMC Females	Race/Age/Ht Match	USMC-R/A/H Match	Race/Age/Ht/Wt Match	USMC-R/A/H/W Match
	n=470	n=3192		n=2888	
Mean	552.82	545.28	7.54	545.50	7.32
St Dev	15.03	14.57	0.45	14.55	0.47
Min	508.00	500.00	8.00	502.00	6.00
Max	613.00	615.00	-2.00	615.00	-2.00
%					
1st	517.97	512.00	5.97	512.07	5.90
2nd	523.00	516.24	6.76	516.28	6.72
3rd	523.91	519.00	4.91	519.00	4.91
5th	527.00	522.00	5.00	522.00	5.00
10th	535.00	527.00	8.00	527.00	8.00
15th	538.00	530.00	8.00	531.00	7.00
20th	541.09	533.00	8.09	533.00	8.09
25th	543.00	535.00	8.00	536.00	7.00
30th	545.00	537.69	7.31	538.00	7.00
35th	547.00	539.32	7.68	540.00	7.00
40th	549.00	541.00	8.00	541.00	8.00
45th	550.03	543.00	7.03	543.00	7.03
50th	552.00	545.00	7.00	545.00	7.00
55th	554.00	547.00	7.00	547.00	7.00
60th	555.40	549.00	6.40	549.00	6.40
65th	557.97	551.00	6.97	551.00	6.97
70th	560.89	552.95	7.94	553.00	7.89
75th	562.00	554.00	8.00	555.00	7.00
80th	564.00	557.00	7.00	557.74	6.26
85th	567.00	561.00	6.00	561.00	6.00
90th	571.85	564.00	7.85	565.00	6.85
95th	578.00	569.30	8.71	569.79	8.22
97th	583.00	573.00	10.00	573.00	10.00
98th	590.00	576.51	13.49	576.55	13.45
99th	594.00	585.01	8.99	584.30	9.70

Menton-Sellion Length

	USMC Females	Race/Age Match	USMC-R/A Match	Race/Age/Wt Match	USMC-R/A/W Match
	n=470	n=3375		n=3201	
Mean	112.79	113.06	-0.27	113.28	-0.49
St Dev	6.04	5.95	0.09	5.94	0.11
Min	97.00	95.00	2.00	95.00	2.00
Max	133.00	134.00	-1.00	134.00	-1.00
%					
1st	99.88	99.96	-0.08	100.00	-0.12
2nd	101.09	101.39	-0.30	101.59	-0.50
3rd	102.00	102.02	-0.02	102.59	-0.59
5th	102.82	103.00	-0.18	103.85	-1.03
10th	105.00	105.00	0.00	106.00	-1.00
15th	106.00	107.00	-1.00	107.00	-1.00
20th	108.00	108.00	0.00	108.00	0.00
25th	109.00	109.00	0.00	109.00	0.00
30th	110.00	110.00	0.00	110.00	0.00
35th	111.00	111.00	0.00	111.00	0.00
40th	111.00	111.00	0.00	112.00	-1.00
45th	112.00	112.00	0.00	112.08	-0.08
50th	113.00	113.00	0.00	113.00	0.00
55th	114.00	114.00	0.00	114.00	0.00
60th	114.00	114.00	0.00	115.00	-1.00
65th	115.00	115.00	0.00	115.00	0.00
70th	116.00	116.00	0.00	116.00	0.00
75th	116.00	117.00	-1.00	117.00	-1.00
80th	117.00	118.00	-1.00	118.00	-1.00
85th	119.00	119.00	0.00	119.29	-0.29
90th	120.00	121.00	-1.00	121.00	-1.00
95th	123.00	123.00	0.00	123.00	0.00
97th	125.00	125.00	0.00	125.00	0.00
98th	126.74	126.00	0.74	126.00	0.74
99th	129.40	128.30	1.10	128.48	0.91

Menton-Sellion Length (cont.)

	USMC Females	Race/Age/Ht Match	USMC-R/A/H Match	Race/Age/Ht/Wt Match	USMC-R/A/H/W Match
	n=470	n=3192		n=2888	
Mean	112.79	113.22	-0.42	113.31	-0.52
St Dev	6.04	5.98	0.07	5.92	0.13
Min	97.00	95.00	2.00	95.00	2.00
Max	133.00	134.00	-1.00	134.00	-1.00
%					
1st	99.88	99.75	0.13	99.92	-0.04
2nd	101.09	101.51	-0.42	101.69	-0.60
3rd	102.00	102.33	-0.33	103.00	-1.00
5th	102.82	103.51	-0.69	104.00	-1.18
10th	105.00	105.97	-0.97	106.00	-1.00
15th	106.00	107.00	-1.00	107.00	-1.00
20th	108.00	108.00	0.00	108.00	0.00
25th	109.00	109.00	0.00	109.00	0.00
30th	110.00	110.00	0.00	110.00	0.00
35th	111.00	111.00	0.00	111.00	0.00
40th	111.00	111.00	0.00	112.00	-1.00
45th	112.00	112.00	0.00	113.00	-1.00
50th	113.00	113.00	0.00	113.00	0.00
55th	114.00	114.00	0.00	114.00	0.00
60th	114.00	115.00	-1.00	115.00	-1.00
65th	115.00	115.00	0.00	115.00	0.00
70th	116.00	116.00	0.00	116.00	0.00
75th	116.00	117.00	-1.00	117.00	-1.00
80th	117.00	118.00	-1.00	118.00	-1.00
85th	119.00	119.55	-0.55	119.00	0.00
90th	120.00	121.00	-1.00	121.00	-1.00
95th	123.00	123.48	-0.48	123.00	0.00
97th	125.00	125.00	0.00	125.00	0.00
98th	126.74	126.00	0.74	126.00	0.74
99th	129.40	128.68	0.72	128.74	0.66

APPENDIX D
Derivation of Statistical Formulae

Appendix D.
Derivation of Statistical Formulae

I. Statement of Precision desired in terms of standard error, using Confidence Limit approach.

Suppose one would like to estimate a population parameter with 95% confidence and a given level of precision. Let C stand for the chosen precision value and S_p stand for the standard error of some parameter, then the confidence limits desired are given by the following equation (Sokal and Rohlf, 1981):

$$t_{0.05,n} * S_p \leq C$$

At 95% Confidence, $t_{0.05,n} = 1.96$ for samples larger than 120, so:

$$1.96 * S_p \leq C$$

$$S_p \leq C/1.96$$

II. Statement of **n** required to obtain a standard error of a given size for estimating the **mean** of a population parameter with 95% Confidence (Sokal and Rohlf, 1981).

$$S_x = \sqrt{(S_x)^2/n}$$

$$S_x^2 = (S_x)^2/n$$

$$n = (S_x)^2/(S_x)^2$$

$$n = (S_x)^2/[C/1.96]^2$$

$$n = (1.96\ S_x/C)^2$$

where: S_x = standard error of the mean of x

S_x = standard deviation of x

III. Statement of n required to obtain a standard error of a given size for estimating the 5th/95th percentile values of a population with 95% confidence. The standard error of the percentile is given by the following equation (Cochran, 1956):

$$S_p = \sqrt{(S_{x^*})^2 + K^2(S_s)^2}$$

where: S_p = standard error of percentile
S_{x^*} = standard error of the mean of x
K = coefficient of the standard deviation used to specify the percentile
S_s = standard error of the standard derivation

Since $S_x = \sqrt{S_x^2/n}$ and $S_s = 0.707 * S_x/\sqrt{n}$ (Sokal and Rohlf, 1981)

By substitution:

$$S_p = \sqrt{S_x^2/n + K^2 (0.707 * S_x/\sqrt{n})^2}$$

$$S_p = \sqrt{S_x^2/n + 0.5K^2 \, S_x^2/n}$$

$$S_p = S_x/\sqrt{n} * \sqrt{(1 + 0.5K^2)}$$

where: S_x = standard deviation of x
K = percentile coefficient

Since $S_p = C/1.96$,

$$C/1.96 = S_x/\sqrt{n} * \sqrt{1 + 0.5K^2}$$

$$C * \sqrt{n} = 1.96 * S_x * \sqrt{1 + 0.5K^2}$$

$$\sqrt{n} = (1.96 * S_x * \sqrt{1 + 0.5K^2})/C$$

$$n = [(1.96 * S_x)^2 * (1 + 0.5K^2)]/C^2$$

where: K = 1.645 for precision of 5th/95th Percentile estimates

IV. Statement of n required to obtain a regression estimate, $y^\wedge_i$, with a given precision and confidence.

A. The standard error for a regression estimate is given by the following equation (Sokal and Rohlf, 1981):

$$S_y^\wedge = \sqrt{S^2_{y.x} (1/n + (x_i - x^*)^2/\Sigma x^2)}$$

where: $S^2_{x.y}$ = residual mean square (RMS)
        n = sample size on which RMS was calculated
        x_i = value of x for which an estimate of y is desired
        x = mean value of x
        $\sum x^2$ = sum of squares in x

B. By algebraic manipulation, the following equations can be derived:

$$S_y^{\wedge 2} = S^2_{y.x}/n + S^2_{y.x}(x_i - x^*)^2/\sum x^2$$

$$S^2_{y.x}/n = S_y^{\wedge 2} - S^2_{y.x}(x_i - x^*)^2/\sum x^2$$

$$n = S^2_{y.x}/[S_y^{\wedge 2} - S^2_{y.x}(x_i - x^*)^2/\sum x^2]$$

C. However,

since $S_x = \sum x^2/n_x$,

$$\sum x^2 = S_x^2 n_x$$

and since $1.96 * S_y^\wedge = C$,

$$S_y^\wedge = C/1.96$$

So by substitution,

$$n = S_{y.x}^2/[C^2/1.96^2 - S^2_{y.x}(x_i - x^*)^2/S_x^2 n_x]$$

D. As can be seen from the equation above, the n required varies as a function of the distance that x_i is from the mean, x. Since precision is desired at the tails of the distribution as well as near the mean, let us assume the case of estimating the $y^\wedge_i$ which corresponds to a 5th or 95th percentile value of x_i. Then,

$$x_i = x^* \pm 1.645 * S_x$$

By substitution,

$$n = S_{y.x}^2/[C^2/1.96^2 - S^2_{y.x}((x^* + 1.645 * S_x) - x^*)^2/S_x^2 n_x]$$

$$n = S_{y.x}^2/[C^2/1.96^2 - S^2_{y.x} (1.645)^2 S_x^2/S_x^2 n_x]$$

$$n = S_{y.x}^2/[C^2/1.96^2 - S^2_{y.x} (1.645)^2/n_x]$$

$$n = S_{y.x}^2/[0.26C^2 - 2.71 S^2_{y.x} (1.645)^2/n_x]$$

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